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Editorial

AUTOPROGRAMMING AND THE TECHNICAL COLLEGE

One of the basic obligations of a college of technology and/or commerce is to keep closely in touch with the educational needs of industry. The college not only trains the engineer, the applied physicist, the industrial mathematician, the accountant and a host of other professional and trade personnel but also offers refresher courses to those already qualified and actively engaged in industry.

These refresher courses, sometimes known as appreciation courses where new techniques and equipment are involved, have now been offered by colleges for some eight years in connection with digital computers and, more recently, automatic data-processing systems. The burden of instruction, in the main, has been born by guest-lecturers provided by the machine-manufacturing companies. Inevitably most courses have been based on particular machines with the reasonable hope that the new ideas involved would become clear by example.

Now the order code for digital computers evolved from the circuitry designed by the electrical engineers and physicists has proved to be a strange and somewhat difficult language to learn for would-be users such as accountants. Yet, in spite of all the attraction of neat flow-diagrams, experienced people still consider that actual programming practice is the basic requirement if the possibilities of computers are to be adequately realised by the potential users.

Very few of the full-time and part-time students at the colleges need to make a basic study of the electronic computer, and indeed, the time-factor alone would make this impossible. Nevertheless, the colleges must now devise, in addition to appreciation courses, suitable training for these students and it is desirable that the instruction should be given by college staff.

Schemes such as the PEGASUS Autocode and the DEUCE Alphacode may well provide the answer. The codes involved have a symbolic form closely akin to the language of mathematics and hence are readily assimilated by college mathematical lecturers. Experienced teachers should not find it difficult to instruct students in one of these codes and to find suitable examples. The examples can reveal all the special points of computer flexibility with respect to counting, discrimination, iteration and modification of orders.

It is suggested that an introductory course of this type is advisable even where a course in basic programming and/or logical design is to follow. Reasonable access to such machines as PEGASUS and DEUCE is possible at a number of educational centres in this country (e.g. the PEGASUS at the Northampton C.A.T.) and a regionalisation of the whole country from this point of view is a practicable scheme. Furthermore, colleges can be readily and economically equipped with paper tape or card punching equipment.

Finally, if this industrial society is to accept the computer along with the other tools of automation, the machine-manufacturers must be able to look to the technical education system to carry out the task. Autoprogramming seems to offer the best chance of giving the present technical college population an understanding of digital computers.

COMPUTER COMMENT

Automatic Programming

On 1 April, at the Brighton Technical College, a hundred representatives of industry, universities, government establishments and technical colleges met to begin a three-day working conference on automatic programming. The Director of Studies was Dr. A. D. Booth of London University.

Many of the representatives had already greatly enjoyed a social reception given by the Mayor in the Royal Pavilion where they were duly enlightened on the social activities of pre-computer days. But the continued temptations of good weather and the beach failed to reduce attendances at morning, afternoon and evening sessions.

Members will be interested to know that the Pergamon Press is to publish the proceedings of this conference but one cannot forbear to mention Dr. Stanley Gill's summary of the computer art:

1830–1951	The coming of the prophets.
1952–1960	The age of dogma.
1961–1968	The dawn of enlightenment.
1969–	The era of progress (the coming of the profits).

There was also C. Robinson's remark, "Programming is like a game of snakes and ladders—with no ladders. Automatic programming is the provision of a few ladders." Amongst the more recondite statements were:

(i) To use this particular autocode we must know something about the basic machine, viz. we must be able to count up to 256.

(ii) To help with the debugging of our program, we make it lousy with checks.

The conference failed to agree on the need for a universal autocode, but there is no doubt that under the stimulating influence of its Director there was a valuable interchange of ideas. The conference agreed that it was essential to define terms such as autocode, interpretive routine, translating routine, etc., and suggestions will be sent to the organiser, Mr. R. Goodman of the Brighton Technical College. The B.C.S. should find this list of definitions a useful contribution to its own work in this field.

At the concluding session, the Principal of the College, Dr. G. E. Watts, indicated that serious consideration would be given to the idea of setting up an information centre on Automatic Programming at Brighton.

* * *

"*Pogo*" *Automatic Programming*

POGO is the name given by *Bendix Computer Division* to a new automatic programming system for its Model G-15 digital computer. Using POGO, it is claimed that highly efficient computer programs can be written by personnel with relatively little computer experience. The letters in the name stand for "program optimiser for G-15 operations."

Using a set of simplified computer instructions, the programmer writes a POGO program. When these instructions are fed into the computer, the machine automatically rewrites the program in its own machine language instructions. It selects the memory location in which to store each instruction, so that processing time will not be wasted in finding the instructions when the finished program is used to solve a problem.

Once the computer is finished with its rewriting task it punches its fast optimised program into paper tape, which can be fed back to the computer whenever that particular problem needs to be solved.

Technically, POGO is a compiler that operates on fixed point numbers. Data are handled in decimal form, with numbers of seven digits, positive or negative. Seventeen accumulator registers are available, and a scale factor is specified in the instruction code. Twelve index registers are provided for use in modifying the effective addresses on which instructions act.

The Bendix G-15 is a low-cost general purpose digital computer used for a wide range of business and scientific applications, and 170 are now in operation throughout the world.

* * *

Change of Address

The Univac Computer Division of Remington Rand Ltd., has moved from 26 Kensington High Street, London, W.8, to Commonwealth House, 1–19 New Oxford Street, London, W.C.1. Telephone No.: CHAncery 8888.

Seat Reservation System

An order for electronic equipment worth $2m. for airline seat reservation has been placed by *Trans-Canada Air Lines* with *Ferranti-Packard Electric Limited*, the wholly-owned Canadian subsidiary of *Ferranti Ltd.*

The order covers booking office and communication equipment which is used in conjunction with a central computer.

The system will be made available in the United Kingdom and the Continent through the parent company, *Ferranti Ltd.*

The system comprises equipment which sends information to and receives answers from a central computer. For this purpose, a device known as a Transactor is used, which will be located in every TCA booking office across Canada. In the larger offices, up to fifty or more Transactors may be installed.

In operation, a pencil marked card is inserted in the Transactor by a TCA clerk requesting a reservation on a certain flight. The central computer determines whether or not space is available on the flight in question and the information comes back to the Transactor causing it to punch a hole in the edge of the card providing the answer to the reservation request.

There were many essential considerations in the development of the system. As the system would have to be operated by ticket agents without electronic training, simplicity of operation was of prime importance. Flexibility was essential to provide for the expanding number of TCA offices. Most important of all, it had to be accurate and reliable.

* * *

S–T–R–E–T–C–H !

". . . The nulls of the interferometer pattern are first plotted as hyperbolas on a plane projection of the celestial sphere. The relative time intervals between crossings of these nulls by the satellite path are marked on a wide rubber band, which is then stretched and rotated until the best fit with the known null pattern is obtained. An improved version of this method involves the use of least-squares techniques and a digital computer to estimate the line of best fit . . ."

(From "Studies of Ionospheric Radiophysics by Means of Satellites," by William C. Hoffman (Rand Corporation Report P-1263, 1-22-58, page 9).

BULLETIN COPY

Will contributors note that the last dates for copy are—

June 1	for	Bulletin 3/2
August 8	for	Bulletin 3/3
October 5	for	Bulletin 3/4
December 2	for	Bulletin 3/5
February 1	for	Bulletin 3/6

COMPUTER FEASIBILITY STUDY

by R. M. Paine

(*This paper was presented to the Society on* 26 *February* 1959)

Introduction

This article indicates how an investigation of a firm might be carried out in order to determine the potential of an E.D.P. system. It will not be dealing with the technicalities of a machine but will discuss the examination of a firm's systems and procedures that is required before deciding to install E.D.P.M. There is no doubt that the amount of initial investigation necessary before deciding on an electronic computer system has been and still is very much underestimated. It is for present-day investigating teams to benefit from the successes and failures that have occurred in recent years.

Full-Time Team

A feasibility study must be a critical examination of existing procedures, an examination that does not just study isolated departments. (Feasibility is a horrible word, but unfortunately, it is in current use.) It is a matter of great importance that at an early stage the true objectives are firmly established—that one knows what is really desired in the way of results. The "real" problems may not be the ones the present isolated manual or mechanised systems are set up to solve. An imaginative yet orderly approach should stimulate a willingness to re-think the company procedure pattern.

A feasibility study is essentially a full-time occupation. The habit of setting up a purely part-time committee to look into this subject is useless. If it is objected that a firm cannot afford a full-time team of two or three, then that company probably cannot afford a computer and is probably not large enough or imaginative enough to use a computer properly. The team should be freed entirely from all previous responsibilities and enjoy energetic backing from the very highest level—with preferably the support of someone on the Board. Their terms of reference should be as open as possible so that they will have the fullest scope in their work, and not a door in the firm should be barred to them.

The decision to have a computer cannot be taken quickly, but should be based on the comprehensive study by a group of responsible people with the active support of at least one member of top management, such as an executive Director of the company. The Director taking an active interest is an essential ingredient to the successful appraisal, since his guidance is continuously needed on matters of company policy, including priorities. It should be understood that it is fundamentally wrong to lay down any specific period for the investigation. The team should even be given time to think!

If a company is not willing to agree to these points should they give up any active interest in computer application and concentrate on something less demanding or more appropriate to their business. There are too many dilettante, un-informed and non-serious firms on the fringe of the computer world, attracted by some sort of glamour associated with computers.

The Investigation

An examination must be undertaken to discover the procedures and facts as they are; and also as they might be unfettered by the present system. To find the facts means hard, detailed, down-to-earth and often boring work. It cannot be passed off as some computer users seem to have done by saying—"My mind is made up—do not confuse me with facts." The analysis of business procedures may be called common sense, but it does require the systematic approach of a trained mind. The techniques used are often given very high-sounding and learned names, but a precis of them is well and simply set out in the "Just So Stories."

> I keep six honest serving men,
> They taught me all I know,
> Their names are What and Why and When
> and Where and How and Who.

The only real difference in applying these ideas to computer applications is that where in the past the investigation was often a limited one, bounded by the needs of one department, the electronic data processing application requires the examination of the firm as a whole. Gone are the confines of departments, and the nicely parcelled up jobs with myriads of checks in between because no person or section could oversee the complete task! For computer applications of today one must consider the work of a firm as a whole from the input of basic information to the output of the final documents and results for the management, customers or legal requirements. It is in the nature of commercial accounts that all processes are related in ensuring the efficiency and profitability of a company. Thus the investigation should be concerned with as many aspects of the company as possible and the inter-linking of the various aspects—it should not just look at the payroll section or the punched card room. It is important to emphasise that no single job may be found large enough on its own to justify the use of a computer, and in these cases only by integrated data-processing would it be possible to secure economies essential to cover the large capital expenditure involved in the purchase and installation of the desired equipment. Integrated data-processing is a pleasant concept, but because of the difficulties involved it has hardly been practised at all.

In placing work on a computer, it is sensible to deal with one procedure at a time and to install each procedure individually, but including the necessary links and then proceeding to integration as a second stage. The use of an integrated data-processing system involves spending rather more time on setting up the system and also imposes the restraint that is not present in a non-integrated system, namely that the output of one routine is the input to the next and must be made compatible.

A short survey of a firm might be useful before the more detailed one in order to determine whether the range of work is such as to build up into a sensible electronic data-processing system and thus justify the cost of a more thorough investigation. Many firms may decide as a result of a short survey by one or two of their own staff or by a computer manufacturer, not to proceed with the longer systems study, or alternatively to consider using a service bureau.

Personalities in the Firm

There is no getting away from the fact that personalities and spheres of influence in a firm count for a great deal in the setting up of a study or in determining its scope. The pattern of departments and the power and actions of the departmental heads or directors will mainly determine in what area of the firm the investigators will be situated—whether they are in O & M, in the accounts, in the production control, in the punched card, in the operational research departments, or even in a new department acting directly under the Board. Wherever situated the job itself remains the same—but because of company organisation, one may have to go about it in different ways. Strong opposition in, for instance, the accounts or punched card sphere can drastically hamper the whole investigation. No matter that we are dealing with the latest in machines—it is people always that are the main consideration. Such a challenge may ensure that the investigators will arrive at sound proposals, but personal interests are at times as problematical as the procedures themselves!

Reshaping Present Procedures

What do we find when we look at a firm's present accounting and statistical procedures? Too often it is a case of "Systems, Systems everywhere and not a stop to think!" Sometimes the lack of co-ordination may indeed be due to the recommendation of previous O & M or punched card studies. In the past the O & M section has probably been called in to deal with some urgent situation, their terms of reference limited by the immediate concern of a local departmental problem—for instance, statements not sent out on time. One may compare this situation to the growth of the railways in this and other countries—many different companies setting up independent lines all over the land, with country-wide transport managing to creak along sometimes even over different gauges. In a way, therefore, one may consider the aims of a computer study in the same terms as the modernisation of the railways—the creation of a unified national command, the treating of the country's transport system as a whole, the elimination of some branch lines, and the removal of duplication and inefficiency. The reader will probably know where in his organisation he can find the "Branch Line Protection Society!"

There is no substitute for hard work—one must do it oneself. There may not be available written procedure records—contrary to what the team may hopefully expect. One must ascertain existing procedures—an accurate and detailed knowledge of the work is required; not its mechanics but rather its aims, its volumes, its inter-departmental flows, its timing, its size of permanent records, its costs and its importance. The little unofficial records and notebooks that are maintained by so many clerks today need to be uncovered and the reasons for their maintenance sought. One must use judgment to decide what is important and what is trivial in existing procedures—one must sift out what may still be required in any future system. The investigators should concentrate on where the initial information can be found—for on this source must be built the systems to provide management information and satisfy other accounting or statutory offshoots. One must try to plan what information is necessary for the proper control of the company by management. Unhappily, management is often unable to commit itself in the matter of current and future requirements. Executives may be so used to receiving information in a certain form that they are not in a good position to help solve the problem of what reports are really required, or to place a value in sterling on speedier reports. There is a possibility that quick availability of pertinent information or logical decisions by the computer based on specified criteria might do away with the need for a large number of reports. But one must gain the management's confidence first, and it would be well to plan in the initial stages of an installation to provide management with the same information as before. With the growth of confidence in the performance of the computer, management may be willing to use exception reports or similar techniques.

It is important to consider the aspect of flexibility and determine how the computer system would react to sudden changes in the statistics required by management, or a sudden hold-up in input data or a breakdown in the machine itself. One must also take into account forecasts of future trends in trading which may bring about large increases in, say, the number of invoices.

The team will need to keep very close to management throughout the period of the study and be kept fully informed of its requirements, so that changes during the investigation—and there will be changes—may be taken into account. The main effort must be to establish the shortest possible route between the original documentation and the final objectives, and, of course, to satisfy various standing requirements—accountancy, audit, legal and statistical—*en route*.

To a trained investigator the shape of a new system and the place in it of a computer will grow in his mind during the collection and sifting of facts. During the investigation he will consider points such as the elimination of unnecessary work; for instance, inter-departmental controls or separate departmental files; a change in the sequence of operations, i.e. delivery before invoicing; an alteration in the number and structure of departments; the possibility of more centralised processing and recording to be compatible with de-centralised sales authority and responsibility; the modification of exceptions to general rules (i.e. some customers receiving special terms or considerations); a change in a difficult price structure; and many other things. The examination of the extent of integration which can take place in the main procedures may lead to the proposal to expand work in the data preparation stage in order to cover a number of requirements from one document. It is almost certain to lead to a revision and expansion of the coding systems. This is the language by which the machines will recognise the information fed to them. Coding is a most important aspect of mechanised or common language systems and success will depend on the manner in which coding is designed and the accuracy with which it is applied.

Flow charts will probably aid the investigation, since graphic forms often show clearly the flow of work in and between departments, and the chain of events. Too detailed flow charts should be avoided, however, until the decision has been taken whether or not to proceed with a computer system.

Punched Card Approach

A strong school of thought supports the view that the best method of approaching computers is by way of installing punched card machines. It is generally recognised that it is easier to change procedures that are already mechanised on punched cards to fully automatic processing, not job for job, but in the general sense of making the change smoother due to the experience gained in the handling and devising of mechanised applications and the existence of at least an embryonic system of coding. It may not be so easy to go straight from a manual system to electronic computer processing. But this does not mean that all applications should be put on to punched cards before being transferred to a computer. A big danger of the stepping stone approach of punched cards, however, is the inclination to re-write punched card procedures as a computer application. It is doubtful if this will produce satisfactory results—as many companies have found to their cost. The attraction of a direct change-over may be that it seems to require less thinking and re-organisation. However, short-sightedness and skimping pay as badly in the long run in the computer sphere as in any other sphere.

When going from manual operations to computer methods it is perhaps advisable to pause and consider whether or not it is possible to obtain the desired results via the conventional methods of punched cards. O and M staffs with computer experience as well as manufacturers' investigators are apt to become technical enthusiasts, and it is necessary to make certain whether simpler forms of re-organisation would not do the job adequately.

How Detailed a Study?

A basic problem is how much study is worth while to get a sufficiently reliable answer; either too little or too much study of systems is wasteful. It has been argued that the use of a computer should be justified only in general terms—it may be wasteful to spend time to get perfection in the early stages of application if the costs of the study might even exceed the cost of a computer. At some point staff activity must be crystallised either through the placing or non-placing of an order.

It may be thought that since a new system for the whole of the firm is the object there is no need to discover in detail the present methods. One can argue that all that is needed is to concentrate on source information, on what management receive at present, and what they really should receive to control the organisation. I believe, however, that it is impossible to evaluate what management receives at present and determine what they should receive in the future, without knowing what is the real business of the firm and how the company actually operates. On the other hand, one should avoid too much immersion in detail or sympathy with the present procedures else one becomes too close to the job to access its wider implications and its re-organisation.

From what has been said one can readily appreciate that it is not really a computer feasibility study that is taking place, but an integrated data processing study with a computer as one of its tools. It is the firm and its activities one is studying and a computer may or may not be useful to the improved plan. There are often benefits to be gained from a wide approach to systems analysis and revision even if a computer is not finally ordered. A computer study gives excellent opportunities to make changes with less than the usual amount of inertia—the glamour of computers does help at times!

Computer Exercises

After specifying the requirements of the task, a survey can be made of computing machinery currently available—perhaps under the headings of capacity, cost, delivery, processing time, flexibility, users' experience, manufacturer's experience of business machines, service and maintenance facilities.

When the team has examined the various computer applications and if, and only if, a good case seems to exist, it may be beneficial to extract jobs and carry out factual exercises on different computers. This will tell

the investigating group just what it means to organise a job for the computer, provide experience in programming and designing suitable output. This can, however, be a lengthy and costly process, so that careful selection of the jobs to be tried is necessary.

Programming exercises are very useful—for instance, some firms have found that machines installed have insufficient storage to do the job in the number of runs planned. A broad look at departments could give incorrect conclusions and lead to the wrong type of computer being selected. An insurance company in the States concluded from a preliminary survey that a particular job could be handled in one run. After detailed programming it was found that six runs would be required because of the small size of store.

Users have found much to their chagrin that storage seems to shrink between initial investigation and actual application!

Evaluating the New and the Old

When the team feel they know sufficient about the present system, and can also outline and evaluate a computer system, it is time to measure the economics of the new against the old and to show any savings that can be achieved. It is generally agreed that benefits may arise in three ways:

(*a*) Savings in staff, machines, floor space, etc., to operate the system.

(*b*) Savings in stocks, overtime, loss of orders, etc., through better control of such areas as production and inventory.

(*c*) Quicker and improved information and service for management, customers or staff.

The first two types of benefits are fairly concrete and by careful study a reasonable estimate in £ s. d. may be produced. The third type is often intangible and, since many applications give rise mainly to this benefit, it becomes quite a headache to investigators to give it a concrete £ s. d. figure. It will be difficult to show factual savings if procedures are merged and it is to be hoped that management will not expect any computer investigating team to be absolutely accurate or detailed in costing the new against the old. It is very difficult to estimate the possible savings in a manager's time as a result of the speedier presentation of information of a more selective type than previously enjoyed. The cry of many a frustrated computer man is "How much easier things might be if economic justification was not required."

The assessment of the value of integrated data processing and the use of a computer should not be left entirely to the "cold" investigation of the accountant. Imagination and leadership are also required—for "every Noble Acquisition is attended with its risks." The investigation will have tried to reduce the risks as much as possible, but in business nothing is a certainty—leaders in industry must always take a calculated risk based on all knowledge available.

The investigators should not be afraid to say that a computer is not feasible if they are doubtful as to the merits or benefits that will be obtained from such an installation, because if there are such doubts then the chances of success may be slim indeed. To install computers the team should be positive that they are going to achieve the results planned, otherwise it is better to wait a while and have another go later when perhaps other factors and changes, not only in the organisations concerned but in the computer world itself, can be taken into consideration. It is a pity if some investigators build up such a vested interest in computers that they cannot admit that computers may not be the best tools for their firms.

There is no quick answer to the question of how much study is warranted before making a decision. The length of the study depends on many factors such as previous knowledge of the firm's procedures, the amount of detail the Board require, whether there is one job large enough to warrant a computer or several smaller jobs requiring some degree of co-ordination, whether the savings are mainly tangible or intangible. Furthermore, the delivery period of a computer can take anything from 6 months to 2 years, and if a computer is ordered it is only the start of more detailed and lengthy planning.

Personnel Required

When starting an investigation one does not know whether a computer will eventually be required—so care must be taken not to seem to pre-judge the issue by the type of people employed. One should try, therefore, if outside recruitment is necessary, to recruit only those people who will be useful to the firm whether a computer is ordered or not. Until a decision is reached to go ahead with a computer it is probable that a systems man with a good understanding of the potentiality of electronic data processing is more useful than a programmer pure and simple. Analysis is often quicker and easier if the investigators know the present system already and are familiar with the firm and its personalities. Teams of two or three people seem desirable and the teams should possess between them knowledge and experience of systems work, accountancy, computers and any special sphere to be considered such as production control. For additional computer experts it may be useful to call on computer manufacturers or even, if one has the money, consultants. If the final decision is to go for a computer the section will, of course, have to be greatly expanded and divided into groups of systems investigators, programmers and operators. Since the company's procedures need to be re-thought, and capacity for concentrated thinking is rare, companies must be prepared to pay high salaries and offer good conditions to those capable of such thought and imagination.

MACHINE TRANSLATION OF LANGUAGES

A Summary by Dr. A. D. Booth of his talk to Members of the Manchester Branch of the British Computer Society on Thursday, 5 February 1959

In order to obtain a proper appreciation of the problems involved in the Machine Translation of Languages, one must start by giving a history of the ideas and activities in this field.

Discounting Russian claims to have started thinking about this subject in 1932, the original idea was suggested by the author during conversations with an American, Dr. Warren Weaver, in 1946, as a possible use for the then "new-fangled" electronic computers. The author was at the time trying to obtain a financial grant towards such a machine for Birkbeck College from the Rockefeller Foundation through Dr. Weaver.

The first idea was to have a full numerical code dictionary, but this had to be rejected because at this date it was not thought that any machine would ever have a store sufficiently large to be of any real use.

A new idea for a dictionary was formulated in 1948; not based on whole words but on stems and endings. This idea was tested extensively on paper, and it showed a reasonable measure of success, and it certainly cut down the total size of the dictionary quite considerably.

In 1949 the Rockefeller Foundation (through Dr. Weaver) circulated a memorandum to all those in the U.S.A. who might be interested in Machine Translation. It stimulated thought, and although some leading linguists were against the whole idea, a small band of workers were encouraged to continue developments of the subject. This led in 1950 to the publication of the idea that even though a lot of the hard work of translation could be done by machine, a more perfect result could be obtained by limited human intervention in the form of a Pre-Editor who removed ambiguities from the original language, and a Post-Editor who put the final (or target) language into its correct grammatical form.

The next landmark was reached in 1952 when Dr. Weaver called a conference of those in Britain and U.S.A. interested in M.T. It consisted of 8 civilian workers and 12 representatives of the U.S.A. Armed Forces. The conference itself achieved nothing visible, but, apart from an exchange of ideas, it eventually had two concrete results. Firstly, the U.S.A. Military Funds made really substantial grants to the furthering of the idea of M.T. in America and, secondly, in Britain the Nuffield Foundation paid for the employment of linguists at Birkbeck College.

This increase in active workers plus the use of the "APEXC" computer led to the first machine translation at the College from French into English; French had been chosen because grammatically it is one of the simplest of languages. Since then German has been tried, but at present the machines are too slow and the stores are too small.

During the years since the Conference a certain amount has been achieved in America. Firstly, *IBM* demonstrated on a limited scale that Russian could be translated into American. Secondly, the Massachusetts Institute of Technology had continued its research into the linguistic problems of translation generally. Thirdly, in Seattle, a special study was being carried out in relation to translations from Russian and the Slavonic languages.

In 1956, the Russians presented a paper to the Institute of Electrical Engineers Conference in which they gave examples of some actual translations that had been done from English to Russian, but certain peculiarities in the finished text suggested that perhaps there had been some post-editing, even though this was denied by the Russians.

At Cambridge, research has been directed towards the thesaurus approach, but this is proving to be rather impractical.

We now turn to the principal methods of locating the required information in a machine dictionary, where the words of the base language are kept in strict alphabetical order. The first method is to keep letters in their 5-figure binary equivalent (this assumes a binary machine), e.g. $ab = (00001)\ (00010) = [1.2]$. The program then looks up "Page" 1 and "Line" 2 for the foreign equivalent, but a dictionary kept on these lines would need to provide for 10^{14} words. The Bible uses about 2,000 different words, Shakespeare about 5,000, and German something like 100,000.

Method two is to store the base language and the target language equivalent side by side. All the words of a sentence are read in and put into order, and a table look up search is carried out to locate each of the words for which a translation is required. This could well take a very long time even on a comparatively fast machine.

The third and last basic method is to maintain the dictionary as in method two, but the search is carried out by the Bracketing Method on each word as it occurs (i.e. the words in the sentence are not put into any order).

**

This method finds the half-way point in the dictionary and then decides in which half the required word lies, then halves that half; this halving process is repeated until the word is located. If there are D words the number of look ups would be $\log_2 D$, or in the case of 10,000 words, say, about 13 or 14 look ups. There are several variations on these schemes, but none have produced very substantial reductions in time or machine space.

The principal groups of workers in the machine translation field are now using the idea of keeping dictionaries not of whole words, but of stems and endings. The stem of the word is normally taken to be the largest part of the word which is common to all its forms, but there are exceptions to this rule. With the stems and endings system the number of words which can theoretically be made is equal to No. of stems × No. of endings, but the storage space required is only No. of stems + No. of endings. The target language is, of course, broken into stems and endings, and these are cross-referenced in some manner to the base language stems and endings; they are usually held alongside each other.

One of the principal difficulties encountered in M.T. is the varying structure of sentences in different languages; this is now being overcome by reading in and translating whole sentences at one time followed by using a program that sorts the words into the required order for the target language.

Another great difficulty is ambiguity; this was first of all, as previously stated, dealt with by a pre-editor, but it was felt that this was wrong if the translation system was to be fully mechanised. An analysis of ambiguities was therefore carried out and it was discovered that by using a Micro or Idio Glossary relating to the subject-matter of the translation, approximately 90% of ambiguities could be accounted for and dealt with automatically.

One way of dealing with the multiple meaning type of ambiguity is to store the several meanings against the base language word, or stem or ending, and to code each meaning to show which one is to be used when a particular subject is being translated. If the subject of the translation is known it is quite easy to program the machine to ignore all meanings except the required one, but a further difficulty arises if the subject is unknown; one way to combat this is to run through the text making a count of the subject categories related to the ambiguous words and then assume that the maximum count is the subject of the text. This category count system would fail if either there is more than one principal subject for the whole of text or if the principal subject changes during the text.

One deals with idioms and the method of coding them in the following way. An idiom is a group of words which, when taken as a whole, has a meaning different from that of the individual words. Therefore it is necessary to make provision in the dictionary for reference to be made from each word to the one or more idioms in the Idiom dictionary in which it occurs, e.g.

Boite	3
de	1, 3, 7, 8, 9, 15, 21
Nuit	3′. (This is a further code to denote final word.)

After discovering 3′ a search is made for this idiom number in the preceding words. It is found that code 3 occurs in both the preceding words, therefore idiom No. 3 is looked up and no direct translation of "Boite" or "de" is attempted.

Some examples of sentences containing ambiguities are now given. The first two contain words with double meanings which could not be translated out of context. They are "She cannot bear children" and "These men are revolting"; the ambiguities being, of course, in "bear" and "revolting." The third example is quite impossible to deal with on a subject category basis; it is "I cannot recommend this book too highly."

There is also the subject of Multi-Lingual Translations by machine. If, for example, it was desired to translate between any 2 out of N languages, it would be necessary to maintain $N(N–1)$ dictionaries, but this could be reduced to $2N$ if a new intermediate language, usually called a Meta language, was invented through which all translations were carried out. This could be further reduced to $2(N–1)$ if one of the N languages was itself used as the Meta language.

As things are at the moment, of course, even if such Multi-Lingual Translations could be logically prepared on paper, there is no machine that would give anything like a satisfactory performance.

Another idea being worked on at present is the possibility of preparing the dictionary itself by machine. The basic idea is to read a text and to record in the store all the different words discovered until the store is full (these would be sorted by the machine into a logical order when they are discovered). After the store is full any new words discovered would be output and this would continue until the text had been completely read. The words in the store would then be output separately for safe keeping and the excess new words which had been output on the first run would themselves be the input for a new run identical in character to the first. This would continue until all the different words had been listed. The several batches of output would then be placed into one single collation. This is, of course, only the basic idea and there are many difficulties to overcome before it is possible to program a machine to prepare its own dictionaries, but it certainly appeared to be an ideal for which one could aim.

Actual French translations are being done at a speed of about 3,000 words per hour on a machine with a speed approximate to that of the PEGASUS. Computer costs (excluding all work such as punching the paper tape or cards), when compared with the cost of a highly skilled human translator, are higher than the human and also, at present, the product of the man has more literary style and feeling.

SOCIETY AND COUNCIL NOTES

Automatic Programming

COUNCIL has agreed to the setting up of a committee on "Automatic Coding for Business Problems" to consider:—

(*a*) a language for defining business problems;

(*b*) whether two-level store computers are susceptible to the technique of automatic coding;

(*c*) to act as a discussion ground for manufacturers and users.

The chairman of the committee is Mr. R. M. Paine of *Shell-Mex and B.P. Ltd.*, and the secretary is Mr. J. H. Wensley of *Computer Developments Limited.* It will work closely with the Research Committee on the Standardisation of Scientific Programming.

Those interested in the possibility of reducing the burden or drudgery of commercial programming are requested to contact the committee.

Towards a Common Programming Language

Interest has been increasing steadily during the last few years in the subject of automatic coding of computer programs. Many schemes have been developed for various computers, both in Europe and in the U.S.A., exploiting in many ingenious ways the ability of computers to manipulate their own programs. While many of these schemes have been welcomed by hundreds of people as a means of reducing the labour involved in preparing programs, there is a growing feeling that something should be done to establish a common scheme which can be widely published and taught. We recently published (*The Computer Bulletin*, Vol. 2, No. 5, p. 81) the introductory part of a report issued by a joint committee set up by the Association for Computing Machinery and the German Association for Applied Mathematics and Mechanics, which described in considerable detail a proposal for an international programming language.

In the summer of 1958 The British Computer Society established a Committee to consider what practical steps could best be taken at the present time towards uniformity of programming languages. This Committee found that since the bulk of the automatic coding schemes produced so far are intended primarily for scientific use it was preferable to concentrate on this type of application initially, and it has therefore confined its attention to this part of the subject. However, it was also felt that some thought should be given to business applications, and owing to the magnitude of the task the Society has decided to establish a second Committee to study this subject. This Committee has benefited from the work already done by the Study Group on Advanced Programming. The two Committees will work in close liaison with each other.

The Scientific Programming Committee has come to the conclusion that the most appropriate way to proceed at the present time would be to seek agreement on a number of individual conventions concerning the manner in which scientific programs are written, without trying to put forward an integrated proposal. In this way we may be able to guide the authors of future schemes without imposing restrictions on them, and by securing a steadily increasing measure of agreement between programming schemes we shall at the same time simplify the description of any one scheme.

It seems inevitable that there will continue to be a number of different working languages for practical use, owing to the variety of types of application and to the peculiarities of some computers. For the publication of papers on computing methods, however, it is desirable to adopt as far as possible a notation which is not tied to one particular system but which can be understood by all programmers. There is therefore a need for a common publication language for describing computing methods. The Committee feels that the best hope at present lies in the development of such a publication language; working languages will, it is hoped, follow the publication language as closely as circumstances permit.

At the present time, the existence of wide differences between working languages is hampering the development of a common publication language. This seems to be particularly true in the United Kingdom, where the lack of machines having large rapid access stores has led to coding schemes which are concerned to quite a large extent with the problem of using two-level stores in a reasonably efficient way. This has distracted attention from the more fundamental issues, and has thus hindered development of common notations.

The Committee has tentatively formulated a few simple conventions, but would welcome at this stage comments and suggestions for consideration, to ensure that any proposals which it makes incorporate the best-available ideas. It is seeking not to impose a programming language, but merely to put forward a number of conventions as a guide for those who are seeking a lead in this subject. The following examples will give an indication of the lines along which the Committee is currently thinking.

The assignment of a value to a variable (which may in practice be taken as synonymous with the contents of a particular storage register), or the replacement of an old value by a new one, may be called for by an instruction in the form of an equation, thus:

$$y = ax^2 + bx + c$$

Note that the use of "=" in this context is different from

its normal mathematical use, where an equation is taken as a statement of fact. Here an action is implied, that of computing a value of a variable. Other symbols have been suggested, but "=" seems to be the neatest acceptable one. Ambiguities are unlikely to arise, but comments on this point would be welcomed.

Only a single variable may appear on the left, and when this instruction is obeyed this variable assumes the value of the expression on the right. The equation

$$y = x$$

means that y is to take the value of x, and not the reverse.

The variable which forms the left-hand side of the equation may also appear on the right, in which case the expression on the right is to be evaluated using the old value of the variable. Thus, for example, the instruction

$$x = x + 1$$

appearing in a computer program would not be a contradiction, but would be an instruction calling for the value of x to be increased by 1.

An instruction may be labelled on the left, the label being separated by a right-hand bracket or vertical line thus:

$$L)\, x = x + 1$$

or

$$L|\, x = x + 1$$

where L is a label.

Control jumps may be called for by an instruction containing the words "go to" followed by a label, thus:

Go to L

When part of a program is to be obeyed repetitively it may be preceded by an instruction of the form

$$x = a(b)c$$

indicating that the following instructions are to be obeyed for each of the values $x = a, a + b, a + 2b, \ldots c$. The Committee has considered various ways of indicating which operations are to be repeated; one way is merely to indent the relevant instruction or instructions, as illustrated in the following simple program for finding a root-mean-square:

$$x = 0$$
$$r = 1(1)n$$
$$\quad x = x + a_r^2$$
$$x = \sqrt{(x/n)}$$

Comments would be welcomed on these points. Clearly they are only the beginning; many extensions are required, and are being considered; suggestions for these are also welcomed. They should be sent to the Secretary of the Committee, who is Dr. S. Gill, c/o Ferranti Ltd., 21 Portland Place, London, W.1.

REGIONAL BRANCH NEWS

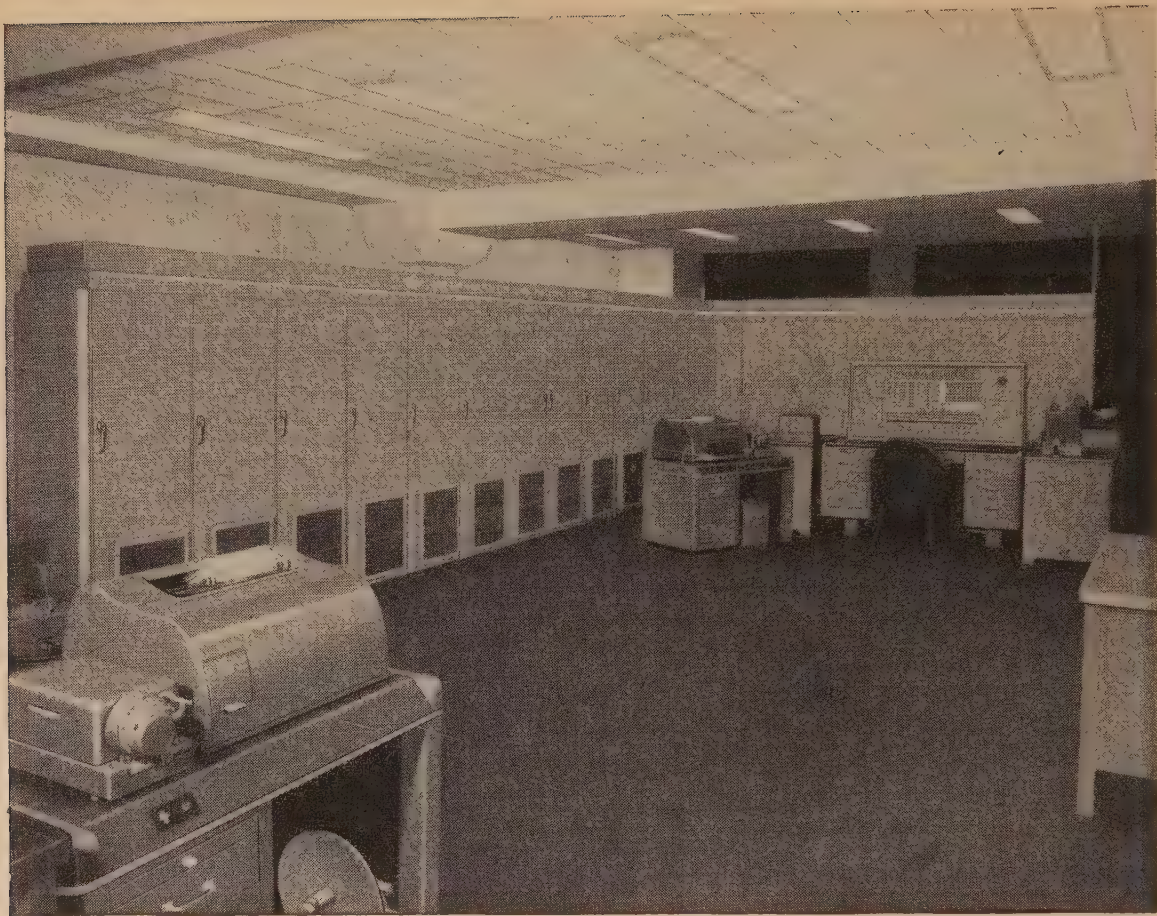
GLASGOW

Attendances at meetings held early in the new year are apt to be very much below those for the last quarter of the old year. It says much for the reputation of Mr. H.W. Matthews of *National-Elliott* that he succeeded in reversing this trend to command a very good turnout of members of the Glasgow Branch to hear his talk on Material Control given in the Montrose Street Extension of the Glasgow Royal College of Science and Technology on Monday, 9 February.

With the aid of slides Mr. Matthews reviewed the electronic digital computers which his company has available to assist in the task and went on to discuss the reasons why it was necessary to exercise Material Control, and looked at the more important of the factors involved. For illustration he specified a system which would be a typical one for a mass production factory, such as might be found in the automobile industry, and showed how the task might be tackled on a NATIONAL-ELLIOTT 405 with the large files of information recorded on magnetic film.

Members enjoyed Mr. Matthews's talk very much indeed, and were obviously stimulated by his ideas, not all of which they accepted without question. One which received some comment at question time was the suggestion that, since computers had now been proved to work reliably, management should accept this fact and allow the computer not only to record the necessity to reorder material, but also to select the supplier and print out the order form itself. Members felt that management would be unwilling to trust the computer this far, unless the reliability of the machine and of the program checks had been demonstrated on a smaller part of the job where the cost of blunders could be limited.

Whilst Mr. Matthews maintained that the battle between having too much on inventory and running out of stock is never won, his audience were almost persuaded that his proposals would achieve the victory!



LEICESTER

On February 25, Mr. N. C. Pollock of *Stewarts and Lloyds Limited* described the LEO installation at Corby.

The computer system was installed in May 1958 and was in effective service on payroll within three weeks after the arrival of the first units. A room of ample size, 80 ft × 30 ft with air conditioning, including cleansing, is being used with ancillary rooms for operating staff. Prior to the use of this system, a payroll of 2,200 was dealt with by the manufacturers in London for a year, on a service basis. LEO is now handling a payroll of 4,500, and this will be extended to 8,000 by June 1959. The auditors are satisfied with the procedure and, although only moderate financial savings are claimed on payroll, considerable benefit accrues from other work.

The repetitive jobs already being processed are

(*a*) payroll and associated routines;
(*b*) pipework stress calculations, now also available on a service basis for other firms;
(*c*) ore-digging production programme; an application of linear programming.

Jobs in an advanced state of planning but not beyond the programme trial stage are

(*a*) warehouse invoicing and stock control;
(*b*) maintenance stores accounting, replenishment and control;
(*c*) the preparation of a general program for multiple correlation and regression analysis.

The tasks making up the payroll are

(*a*) calculation of gross pay due;
(*b*) reduction of gross to net;
(*c*) the keeping of all the financial accounts affected by pay;
(*d*) the allocation of gross pay to cost accounts;
(*e*) the provision of labour statistics.

The two principles observed in the payroll job organisation are

(*a*) avoid human intervention in the process and make the computer do as much as possible;
(*b*) take the utmost care with respect to the accuracy of the basic data.

In reviewing the experience gained, Mr. Pollock re-emphasised the need for accuracy in the basic data. He advised a generous estimate for planning and programming in terms of time and cost. There was always the re-organisation problem since the computer system cut across departmental barriers. The year's experience on a service basis with the manufacturer had proved invaluable and the actual installation had proved very reliable.

In conclusion, the speaker mentioned that the Australian company of *Stewarts & Lloyds* used the computer, and the South African company was likely to commence using LEO in the near future.

The final branch meeting of the session was on March 18. Mr. D. W. Hooper of the *National Coal Board* spoke on Automatic Data Processing.

Seven years ago the *N.C.B.* initiated an inquiry into the possibilities of improving on the varied forms of mechanisation then in use. It was possible to draw on very little experience; not even the U.S.A. had much to offer. However, studies were continued and eventually A.D.P. arrived in 1959. The word "automatic" has replaced "electronic" since only the heart of the system is electronic. Since so much of the ancillary equipment involves mechanical movement it is disappointing that progress here has been so meagre compared with electronic developments. However, there are now signs of better speeds with respect to cards, paper tape and printing. Magnetic tape offers the greatest possibilities for input and output, but is not suitable for all types of jobs.

Some of the chief points made were:

(1) Management should trust A.D.P. and only exception statements need be printed, much paper work being cut out.
(2) Office systems are frequently years out of date. We cannot link these up with computers. The decision to install a computer has always forced complete mechanisation because the mechanics of processing the data demand a logical stream-lined approach.
(3) Programming can become a relatively junior coding job in the business world if the problem has been reduced to "arithmetic thinking."

In conclusion the speaker looked to some possibilities in the future. There was the idea of the computer searching for information and directing the search using past experience for success or failure as a guide. The idea of using past experience might also be used for budget purposes. A second possibility was the eventual disappearance of departmental boundaries so that A.D.P. was displaced by I.D.P. (I = integrated).

In answering questions, the speaker revealed that 3 of the 50 areas of the *N.C.B.* has been selected for A.D.P. One such system was in action, the second just about to start and the third well on the way.

MANCHESTER

Branch Meetings

The monthly Branch meetings are held in the Reynolds Hall, Manchester College of Science and Technology.

On 5 February 1959, Dr. A. D. Booth of the Department of Numerical Automation, Birkbeck College, University of London, spoke on "The Machine Translation of Languages."

After dismissing a Russian claim to have started first, Dr. Booth said there was evidence to show that the history of the subject started in 1946. He described how thought had progressed up to the present time, including the various methods of storing, locating, and cross-referencing information. Dr. Booth told his audience of the various difficulties that had to be faced, and gave some amusing examples of ambiguities.

During the course of answering questions, Dr. Booth said that as yet it had not been possible to get as good a finished product from a machine as from a skilled translator, nor could it be produced (at present) as economically, but it was hoped that as machine capacities and speeds increased, the tables would be turned.

On 3 March, Mr. C. W. Mallison of the Treasurer's Department, Cheshire County Council, spoke on "Local Government Payroll."

The installation in Chester at present consists of a basic IBM 650 system with a line-printer working on line. The lecturer explained why, firstly, an electronic calculator and, secondly, a computer had been used for doing payroll work for 18,000 employees. He also described how the difficulties had been surmounted, and was justifiably proud when he was able to say that all programmers and console operators had been found within the organisation and that all the programs, except one, had been written by the department's staff. Mr. Mallinson indicated the principles underlying the several district groups of payrolls and gave his audience some interesting figures of activity rates.

Beginners' Study Group

At the February meeting members who had visited the Computer Exhibition gave their impressions of the Exhibition, and described the various items of equipment which they had found interesting. Literature obtained by members was passed round and the merits of the items were compared and discussed by the Group.

A representative of ICT gave a very interesting lecture in March on the PCC. He described at great length its components and its logic and finished his talk by showing how, in principle, the machine could be programmed to carry out certain data processing routines.

By the time this is published the Group will have visited Manchester University and seen a Ferranti MERCURY in action. It is hoped that if this type of visit proves popular, more may be arranged in the future.

MIDDLESBROUGH

On 8 October, R. A. Fairthorne (*R.A.E. Farnborough*) spoke to the branch on "Sorting and Marshalling."

On 11 November, a party visited the *I.C.I. Computing Section* at Billingham to see the ELLIOTT 402 computer and to be told something of the work done on the computer. Dr. Levy and his staff had obviously given much thought to the organisation of the visit. Dr. Levy began with a general introductory talk on the uses of the computer. He was followed by Mr. W. F. Volume, the maintenance engineer, who gave an account of the main technical features of the computer. The main part of the visit was the running through of two short programs for (*a*) the simulation of ten weeks of operation of a small road tanker fleet in order to investigate the optimum size of fleet to meet a given demand pattern, and (*b*) the determination of molecular energy levels. These were under the control of Dr. C. M. Reeves and Dr. H. H. Greenwood respectively, and they each gave a short preliminary talk on their problem.

On 7 January, C. Strachey (*N.R.D.C.*) addressed twenty-four members and guests of the Branch on "Some Aspects of the Logical Design of Very Fast Computers." The title was perhaps misleading since the speaker dealt in a general way with the likely developments in large computers in the next decade. As an indication of the rate of development the speaker observed that the latest large machines were a thousand times as fast as the first digital computer, the HARVARD MARK I of 1944 and, in turn, by the end of the next decade, the present speed would be multiplied by another thousand, and the unit of "clock" time would be the time light takes to travel a foot. Among other points mentioned by the speaker were the use of core-stores, transistors, time-sharing, auto-codes. A very full hour of discussion followed in which the main topic was the relative merits of auto-coding and machine-coding. Mr. Strachey maintained against considerable opposition that for routine problems the future lay with the auto-code and every engineer his own programmer.

Study Groups

The committee is keen to have at least two study groups working on Tees-side within the next month or two—one on a scientific or engineering project and the other on a business project, but so far no concrete projects have been put forward for study.

If no other business projects are suggested, the Borough Treasurer will be glad to let a group study the application of a computer to the work of his department, although he does not contemplate using a computer in the immediate future. However, the work of the department has recently been studied by several manufacturers of punched card equipment, and the flow of data is, therefore, available to a study group. It comprises mainly payroll for weekly and monthly staff, rate accounting, costing and stores control, analysis of expenditure and payment of creditors, and many smaller jobs such as stock, dividends, etc.

NEWCASTLE

On 6 January, the branch was addressed by Mr. C. Strachey (National Research Development Corporation), who took as his subject "The Logical Design of Computers." This fell into two sections:

(i) The actual layout which was part of the overall system.
(ii) The electrical composition which required far more logical application.

Over the past few years there had been considerable developments in the speed of operation of computers, and in this respect the application of certain types of transistors had been of considerable advantage. Whereas original time had been measured in milli-seconds and micro-seconds there was now a tendency to express time

in milli-micro seconds. There was, however, an absolute limit to speed which was imposed by the speed of light and the relative sizes of all the components and the expression "light foot" was a time which might assume considerable importance in future computer developments.

The lecturer then considered the new fast computers like the proposed STRETCH and pointed out that such machines are necessary to do certain problems in connection with advanced physics which only their speed and storage could tackle.

Periods of idleness were bad things for any machine, but for a fast machine they will be absolutely unpardonable, and in order to avoid them time sharing would be the regular order of the day, with the machine doing one or two regular jobs but programmed to break off for other functions as required.

At a meeting held on 3 February, the branch was addressed by C. E. G. Bailey of *Solartron*, who opened his lecture on "Character Recognition" by stating that we were at the equivalent stage with character recognition that we were with the aeroplane in 1910. It had just been proved that it could be done, but very few people had, in fact, got equipment to do it.

He then outlined the various requirements for recognising any character, and the limitations which were imposed by inks, papers, and type faces.

He explained how the SOLARTRON equipment worked, the method of scanning and the logic of the interpretation, dealing also with the degree of accuracy experienced. The lecturer also gave an outline of the likely development and scope of his equipment. The lecture was followed by a very brisk and forthright discussion on possibilities, limitations and achievements to date.

The branch was addressed by Mr. D. T. Caminer on 3 March, on "Some Applications of a Computer in Industry." The lecturer stated that he would break away from the conventional subjects of payroll and pure costing, as they had been treated so often, and deal with two more unusual applications. The first was in connection with the digging of minerals from opencast workings, where there were up to a dozen points at which digging took place to supply up to five consumer points. The basis of the application was that in the digging a fixed area was laid down as being the unit for excavation, and test borings ahead of this were taken at regular intervals. Based upon the analysis of these test borings the composition of the mineral was analysed into its various component parts.

But the factory required different compositions and yet because of the variation in composition of the raw mineral an effort had to be made to reduce variations in quality to the very minimum. The test borings were taken up to five days ahead of normal working, and the computer determined the amount of mineral to be excavated from each site to supply the various requirements, and also prevented exhaustion of any particular section because of the known variation for the next five days. In addition, the computer determined the number of wagons which had to be at each site and their delivery instructions to the various processing centres.

It was possible to deal with a matter such as this on a linear programming basis, but the company, after studying the problem, came to the conclusion that because of the additional speed and storage facility available in the computer it was better to examine the variations which took place by taking one wagon load from different sites and to see what the effect would be, carrying this process until the required allocation and composition had been obtained. If it seemed a long and crude method, in actual operation, it was proving very effective and very quick; the whole time allocation on the machine, was of the order of 2/3 hours per week, and was a very suitable additional job for the computer already in existence.

The computer held in its store all the day to day data, and following each day's excavation the actual amounts which were dealt with were fed into the computer to amend the estimate for that day, and to make the necessary adjustments to the stocks.

This job had previously been done very much by rule of thumb and by experience, and with the new method there was available a considerable amount of statistics on deviations and on comparative compositions at various places. In addition it was enabling a much more uniform standard of output to be obtained.

The program to deal with this application contains some 20,000 instructions, and held approximately 2,000 words in high speed storage.

The second application was to a light engineering company dealing with 2,000 finished parts, 4,000 subassemblies and 60,000 raw materials. Distribution of the goods took place through nine depots and one especially for export, all of which were supplied from a central warehouse on an imprest basis, with the central warehouse being supplied direct from the works.

The computer was planned to keep each district depot supplied with goods, to arrange for the supply of invoices at standard rates and also to provide forecasts every five weeks to maintain the level of stocks at the various depots. In addition it was used to calculate the level which would ensure the smoothest running of all machines, to produce all works documents and to record all batches.

In addition it carried out a comparison of the production schedule with the actual results obtained and also determined raw material requirements. As an additional process it dealt with the payroll which was mainly on a piecework basis.

The computer itself had 16,000 words of auxiliary store and 2,000 words of high speed store. There were two input channels, one for punched cards and the second for paper tape or for magnetic tape. There was provision for four magnetic tapes for use as additional storage. On the output side, this could be either punched direct into cards or by SAMASTRONIC printer as an on-line unit, or alternatively on magnetic tape.

Basic data including the current specification, sub-

assemblies required, and final products in all their details were held on magnetic tapes. It was planned also that every five weeks there would be a revaluation of costing rates and also a re-rating of payments for various jobs. This was something which had always been very difficult on any other method than a computer. Additional information which was provided was as follows: once per year, the right layout for the job and the frequency of production were determined, so that it was possible to compare the actual cost of holding a product in stock as compared with setting it up on pre-determined occasions; deviations between the actual and the forecast were also calculated, and after the requisite batches of production had been calculated the computer smoothed these out to avoid violent fluctuations (i.e. to prevent heavy overtime in one week, and short time in the following).

The installation had not yet gone into operation fully and at the moment was being operated on a service basis, in the build-up stage, so that by the time the computer was delivered the whole of the system would be working.

UNIVERSITY NEWS

Deuce Computer at Liverpool University

The University of Liverpool has ordered an *English Electric* electronic digital computer, DEUCE, and the machine, a Mark I, is being installed at the University's Ashton Hall Mathematical Laboratories. The Liverpool DEUCE will be operational in the early summer and will enable the Laboratories to expand very considerably the services they offer both to university departments, such as the nuclear physics and oceanographic departments, and to outside organisations. Time on the computer will also be offered, as it becomes available, to local industry on a time-hire basis.

The University is proud of the fact that a large part of the sum required to cover the cost of the installation has already been raised in donations received in response to an appeal. It is hoped that before the appeal list is closed, the cost will have been largely met by the private donors and organisations that have subscribed in this way.

The computer is being built and installed by *English Electric Company's Data Processing and Control Systems Division* at Kidsgrove, Staffordshire, and will be equipped with seven-hole paper tape input/output as well as a 64-column punched card system. It is the twenty-fourth Deuce to be produced by *English Electric* and the second to be supplied to a British University.

CORRESPONDENCE

Letters from readers are welcomed, and should be addressed to The Editors, The Computer Bulletin, Finsbury Court, Finsbury Pavement, London, E.C.2. The name and address of the writer must be given, but will not be published if requested.

Computer Exhibition

Sir,

Under the heading "What Type of Society?" the February/March edition of the *Bulletin* reached the conclusion that the Society was a mixture of different types of people, and it therefore seems a pity that the approach to the reporting of events is normally from the scientific standpoint only; surely more attention could be given to the commercial side of digital computing.

The report on the equipment on view at the Exhibition is an example of this scientific outlook. One of the most significant facts about the Exhibition to the business man visiting Olympia was that he was able to see complete large-scale Electronic Data Processing systems—and see them working. Taking our own Company's stand as an example, our exhibits featured a complete E.D.P. installation. This included a NATIONAL-ELLIOTT 405 computer equipped with paper tape and punched card input, paper tape and magnetic film output, together with a comprehensive range of data preparation equipment, off-line magnetic film and paper tape controlled printers. All this equipment was active in live demonstrations and it is worth noting that the storage of the 405 included nickel delay lines, magnetic disc and magnetic films. The disc itself of 16,384 words was worth a mention in the section headed "Storage Devices." Other stands, notably *I.B.M.* and *Ferranti*, were also showing complete large-scale systems.

To the commercial world, it is the performance and ability of these complete systems that is of chief interest, yet it is not likely that a reader of the Bulletin would realise that such systems were on show at the Exhibition.

It is also desirable to classify digital computers under two headings; those principally commercial and those principally scientific, although most manufacturers would claim that their equipment falls into both categories. To consider machines of the nature of the NATIONAL-ELLIOTT 802 and the METROVICK 950 to be of the same category as LEO II, NATIONAL-ELLIOTT 405, EMIDEC 2400, HOLLERITH 1400 and PERSEUS tends to create a false impression regarding the relative importance and different uses of these machines.

A minor point concerns the use of the expression "time-sharing". For years now this has meant the parallel operation of different parts of the same computer while obeying the instructions from one program. Nowadays it is tending to mean the parallel operation of more than one program, and it would seem preferable to refer to this second effect as "Parallel Program Operation," since time-sharing in its accepted sense has been operative for several years and is not a subject to be described as something "about which a fair amount has been written and talked."

Yours, etc.,

A. H. Beaven,
Head of Programming Services Electronics Group

The National Cash Register Company, Ltd.,
206–216 Marylebone Road, N.W.1.

BOOK REVIEWS

Facilities for Data Transmission

G.P.O., London, 1958. Issued on request.

This is a 21-page booklet giving an up-to-date picture of what the G.P.O. will provide to help organisations who wish to transmit data, and some indication of the cost.

Part I of the booklet is a general summary of existing practice in non-technical terms, while Part II is a semi-technical account of the types of circuit which could be made available for data transmission. Anyone considering data transmission, of a kind more advanced than making the best use of TELEX or ordinary telegraph lines, will find Part II most useful preliminary reading.

The general impression that this booklet leaves is of willingness on the part of the G.P.O. to discuss with and, indeed, to help organisations who wish to design or employ data links of higher speed or lower error rate than those at present in use.

I. V. IDELSON

* * *

Handbook of Automation, Computation and Control—Vol. 1, Control Fundamentals

Edited by Eugene M. Grabbe, Simon Ramo and Dean E. Wooldridge, 1958; 1,024 pages. (New York: *John Wiley & Sons, Inc.* London: *Chapman & Hall Ltd.*, 136s. 0d.)

This is the first of three volumes, produced by a panel of 29 specialists under the editorial guidance of a senior staff consultant and two executive vice-presidents of the Ramo-Wooldridge Corporation, Los Angeles. The remaining two volumes will cover *Computers and Data Processing* and *Systems and Components*. The appearance of this well-bound and heavy volume on a London desk in mid-November with a preface dated August 1958 is, in itself, a record of the era in which we live, when "accelerated advances in technology have brought a steady stream of automatic machines . . ." and "growing complexity and speed of business and industrial operations" (p. ix). The *Handbook* is directed towards all problem solvers, engineers, scientists, technicians, managers and others, concerned with the development of automation. The aim of the series is to bring together the available theory and information on mathematics, feedback control, computers, data processing and systems design, with emphasis on practical applications, new techniques and components, and "the ever broadening role of the electronic computer." It is envisaged by the Editors that practising engineers will find it to be an information source and refresher, while managers will use it as a frame of reference and background material for understanding modern important techniques.

It is intended that topics in new fields should be given in more detail than older subjects.

All sections are copiously illustrated with charts, graphs and mathematical equations. One who had earlier obtained a reasonable facility in mathematics leading to statistics, found that the attempt to compress everything from moments-of-a-frequency-distribution to Monte-Carlo into 17 pages led to a certain roughness of definition, which might make the theory therein described of misleading value to the stray visitor from another discipline; nor could one, who has spent many years trying to persuade his more mathematically enthusiastic assistants to spend a little more time in establishing unambiguous definitions, accept the view that "Statistics is the analysis of probability distributions on the basis of a number of experimental observations." This may be true in the research establishment or factory, but the *manager* needs a wider definition if he is to appreciate also what might be done in the business field.

One description of a mathematician in industry is that if he cannot remember details of a method at least he can quote a reference. If nothing else this book will provide him with an ample supply of good references—even time-honoured ones such as Goursat, *Cours d'Analyse*, have not been forgotten.

With the greater part of the book devoted to operations research, information theory and feedback control the aim of the authors becomes apparent in these sections. The section on operations research, for example, is sufficiently wide to be appreciated by a technical manager yet it has enough detail on linear programming to provide a useful background for fuller study.

For a work covering such a vast field some lack of definition of symbols would be expected, but throughout every attempt has been made to reduce this. The section on Feedback starts with a chapter of ten pages (three references) on the Methodology of feedback control and defines both symbols and expressions in alphabetical order.

The decimal and sectional page-numbering system would appear to have been designed originally for a loose-leaf volume. The page numbers involve no loss of precision (there is a comprehensive index of 20 pages), but a conscientious reviewer, away from his accustomed mechanical aids, must depend on mental arithmetic to satisfy the librarian's requirement for a size indication in the heading of the review. The book is intended for reference rather than reading, but in view of the uneven "record length," and absence of section markers, the time for retrieval of information is more comparable to a search on magnetic tape than switching within a truly random-access memory!

The production of a handbook—especially on such a new field—must be accompanied by some risk of outdating. Time will determine its true place, but for an organisation with a limited library this book should prove a bargain.

Minor criticisms of detail apart, the work is a truly monumental piece of co-ordinated effort for the editors who were not however new to these tasks, having previously collaborated on *Automation in Business and Industry* (Wiley, 1957). It is at no point trivial, and if the two volumes which are to follow are as good, then the set will deserve a place in every reference library where organisations or individuals are concerned with the study or application of our new techniques and tools.

P. G. BARNES
H. W. GEARING

Review of Proceedings of the Fourth Annual Computer Applications Symposium, 24–25 *October*, 1957

126 pages. (Published by *Armour Research Foundation of Illinois Institute of Technology*, $3.00.)

The papers presented at the A.R.F. Symposium are at first sight about quite unconnected subjects. However, they can be put into four classes, representing some of the main lines of thought in present-day computing.

First there are papers about problems where the use of a general purpose digital computer is questionable. These are problems which can be theoretically solved on general purpose digital computers, but where there may be more economical methods of attack. An interesting example is presented by the paper on Metropolitan Transportation by J. D. Carroll, Jr. Here, after starting analysis with a conventional computer it was found that two special machines would provide a better attack on a large section of the problem. Further examples are given by the papers, "A Dual-Use Digital Computer for Dynamic System Analysis," by Clamons and Adams, where a combined general purpose machine and digital differential analyser is recommended; and "Progress in Computer Application to Electrical Machine and System Design," by E. L. Harder, where there is a discussion on the respective fields of electrical machine and system design in which analogue or digital machines are preferable. Another problem in this class is a discussion of the Air-Line Reservation, a small problem by R. A. McAvoy.

Second, there are papers about particular data processing applications of computers. The paper on a Hospital Record-Keeping System, by R. J. Koch, is interesting as providing an application which essentially demands magnetic tape, fast in comparison with presently available tape mechanisms. The paper on Data-Processing Tasks for the 1960 American Census, by Heiser and Armstrong, will be interesting for those with the responsibility of organising a large data processing centre, for it discusses some of the staffing and running problems which often appear only after installation.

Third, there are a number of papers on scientific applications. The paper on "Statistical Calculations in Product-Development Research," by E. B. Gasser, is one of the few accounts of the use of a relatively small computer.

Fourth, there are two very interesting papers on Automatic Programming, one by R. W. Bemer gives a good account of existing scientific automatic programming systems and is, I believe, the first published catalogue. The second paper, "Automatic Programming for Business Applications," by Grace Hopper, is a most persuasive plea for automatic programming in data processing applications and does, I believe, show that this is possible now and will become commonplace in the next few years.

I. V. Idelson

Electronic Digital Computers: Their Use in Science and Engineering

By Franz L. Alt, 1958; 336 pages. (New York and London: *Academic Press Inc.*, 80s. 0d.)

This book is intended to provide engineers, physicists, chemists, and other scientists with enough information to talk intelligently to computer specialists. It comprises five parts, an Introduction, a section on the development and construction of computers, a section on programming, a section on "problem analysis," and a final survey of applications, including some general remarks on computing laboratory organisation.

Easily the best of these parts is the section on problem analysis, which is a thinly disguised text on numerical analysis. As might be expected, the author is completely at home on this ground; so much so that he sometimes seems to go beyond the "mathematical background required of the reader" in the preface. I am sure that some of the engineers, chemists, experimental physicists, and all of the students of the social sciences in my University, would occasionally fail to follow the mathematics.

His survey of applications appears to me to be too vague and insubstantial to be grasped by the practical reader, who would prefer to see many more problems discussed in detail. There are engineering calculations, for instance, being done by hand now, which would be more efficiently tackled by a computer, but no concrete example of such a calculation is given. Furthermore, there is a dearth of references in this part of the text—surely, one feels on reading the brief description of a topic, *some* actual computing has been done and published on this interesting subject.

Reverting now to the more introductory parts of the book, we are treated to yet another version of computer history. The author can justifiably claim that his account is more authentic than most so far given. We are spared the horrors of the knotted string era (see *The Computer Bulletin*, Vol. 1, p. 193), skip lightly past Babbage (on the excellent grounds that he did not influence later development, though I do feel he might have been spared a passing salute for being 100 years ahead of his time), and plunge into early Harvard. For a brief moment we emerge from a welter of relays to eulogise our electronic ancestor, ENIAC, and then return to later Harvard, and the magnetic drum. The fact that Booth ever thought of a drum and that the Manchester drum was working in 1950 has sunk without trace, the existence of firms (other than Ferranti) in Europe is ignored, whilst the chronological order of events is difficult to follow in the ingenious muddle in which development is presented. But it may be that the whole development *was* an ingenious muddle, anyway, so that the impression given is correct, even if not wholly intentional.

The weakest part of the book technically appears to me to be the section on programming and coding. There

is no attempt to present programming as a coherent discipline, as has been done with numerical analysis. However, machine operation is given a sensible treatment. It is a pity that the whole subject has not been dealt with more fully. Running through the remarks on programming is the idea that the planning of a problem and the preparation of a program in some code acceptable to the machine are necessarily and desirably separate operations. The theme is expanded in the final chapter on the characteristics of computing laboratories, and expresses itself in the author's advocacy of the "closed shop" principle, the laboratory being organised to operate as a specialist service department for users.

I do not myself believe this to be desirable, particularly in scientific and engineering use of computers. We, in Leeds, have found little difficulty in training research workers in "coding" in less than two weeks, even when we have been teaching the somewhat clumsy machine codes now available, and this parallels earlier experience at Manchester and Cambridge. On future machines the codes will, no doubt, be more easily learnt. Our experience would also indicate that undergraduates can learn coding even more easily than research workers. Since expert numerical and system analysts are scarce, it is surely better to employ these people to act as mentors to the originators of problems, leaving the latter to code the work for the machine themselves after suitable brief training. This "open shop" principle has worked well in many universities, including Cambridge, Manchester, Illinois, and here in Leeds. It seems to me entirely suitable for adoption in business organisations using a machine to act as a service centre for a variety of activities such as operational research, engineering design, and so on.

Despite the criticisms set out above, I found the book full of interest. The author has set out clearly and well the many practical snags in installing and using a computer for scientific work, and has shown how these may be overcome. To sum up, it is a useful text.

A. S. Douglas

* * *

DATA PROCESSING—A Quarterly for Top Management and Chief Executives

Vol. 1, No. 1, Jan.–March 1959; $7\frac{3}{8} \times 10\frac{1}{4}$. (London, *Iliffe & Sons Ltd.*, 25s.—£4 per year.)

The appearance in *The Computer Journal* for January of a reply-paid folder announcing the new *Iliffe* quarterly will have given many members the opportunity to consider this new arrival in the computer field. It is aimed at keeping top management and chief executives abreast of new methods, to reveal where and in what way they can be applied to businesses, and in consequence the journal will attract more commercial and industrial applications than scientific ones. There will, however, be information from time to time on specialised output devices, such as graph plotters.

We assume that most of our members who are already working close to computers will find little which they have not already ascertained from their closer contacts with people working on computers and from our own publications. But *Data Processing* will nevertheless be an indirect help to them: some management and financial journals have in the past been more helpful than others in giving accurate information to top mangement; this new one corrects the balance in favour of greater precision and less misinterpretation.

The first article is a review of the functions of computing services by Mr. P. L. Young (*Ferranti Limited*). In it (p. 5) we find justification for our B.C.S. editorial policy—"a man who uses a computer for one job soon sees possible applications to related jobs." This article includes a review of available service centres in the U.K.

The second article explains the SOLARTRON developments in character recognition with illustrations of prototype equipment and a clear description of the principles involved. "The Universal Language of Computing" gives a simple explanation of binary numbers, binary arithmetic and decimal binary codes. Mr. M. H. Johnson (*Ferranti Limited*) contributes a paper on "How an electronic digital computer calculates," which many of our Business Group readers would find helpful to keep their more curious accountants happy. "Automatic programming" by Mr. A. E. Glennie (*U.K.A.E.A.*) offers the hope and explanation of the latest facility. Fourteen pages are devoted to a review of computers available in Great Britain, with a short glossary, and this gives the numbers of each make installed in Europe at the end of 1958. Mr. A. A. McPhie (*Powers-Samas*) describes the Wages and Labour Costing System of *Sperry Gyroscope Company Limited* performed on punched cards and an EMP.

The final papers are on "High Speed Printing," covering the XERONIC printer, and "Industrial Inspection," covering semi-automatic methods of quality control.

There are 64 text pages in this first issue, uninterrupted by advertisements, but well laid out with illustrations.

Those who are fully occupied with detail on computers may find *Data Processing* a convenient means for general education in their establishments. The price of £4 per volume appears to be rather high, but it could not be much less where an editorial staff is employed. If we may venture a recommendation to a company, which has been in the publications business for many years with over 30 other well-established journals to their credit, it is that all papers should be signed and that, where possible, references might be given to some of the original work in which more precise details may be found. It is suggested that this would co-ordinate the educational function of introductory and descriptive literature with that of our more technical and scientific journals and thus help to break the barriers of communication between scientists and managers.

H. W. Gearing

* * *

NEWS FROM MANUFACTURERS

Pegasus 2 Data Processing Systems

Many people have used or know well the original PEGASUS computer, henceforth to be known as PEGASUS 1. *Ferranti Ltd.* are now marketing a new version of this computer known as PEGASUS 2 which is designed to serve as the centre of electronic data-processing systems. This new version has facilities not embodied in the original machine. These simplify working with the mixed alphabetical and numerical information common to commercial data-processing. It can also have associated with it a wide variety of punched card machines, magnetic tape equipment and fast printers which can be grouped in different ways to suit the needs of many different organisations.

Changes in the Basic Computer

It is claimed that the basic PEGASUS 2 has about twice the computing "power" of PEGASUS 1. The main differences are as follows:—

(1) The speed of the two input paper tape readers has been increased from 200 to 300 characters per second.

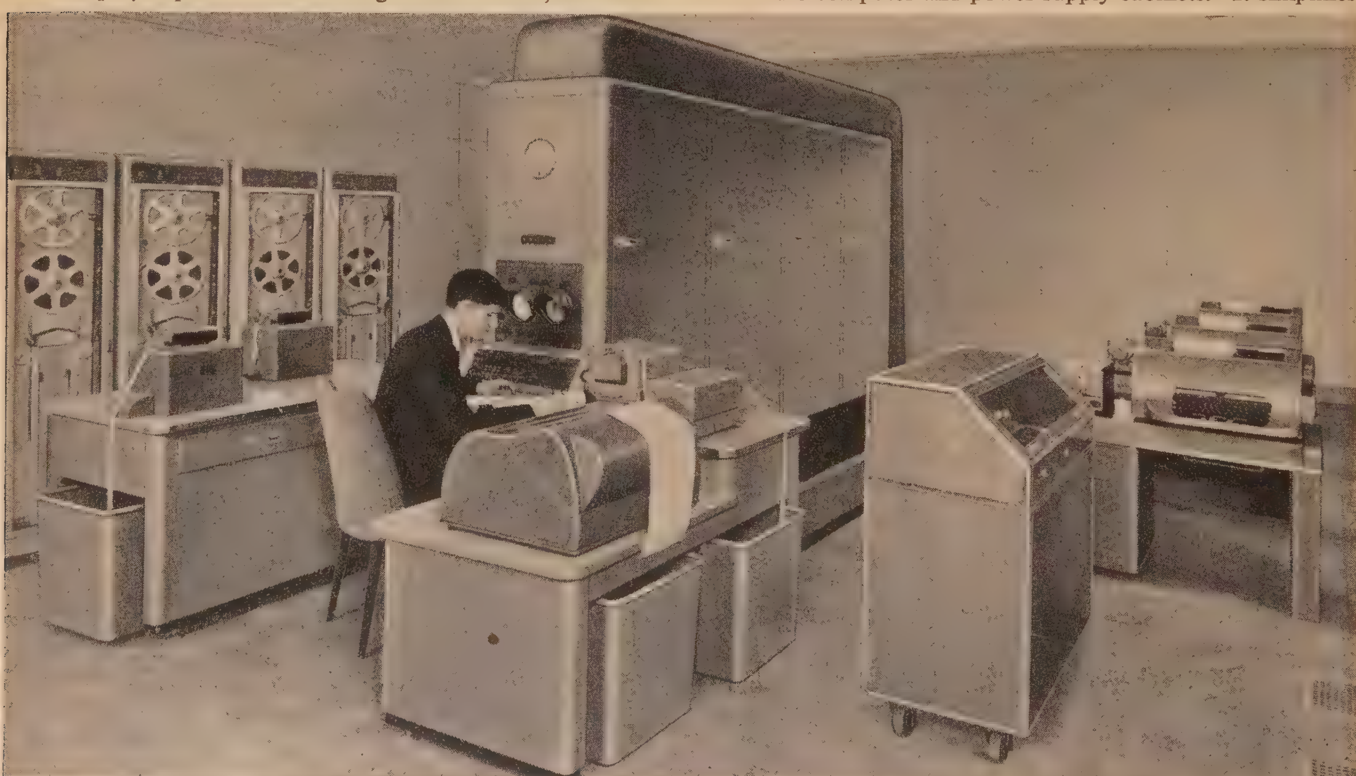
(2) A fast output paper tape punch of 240 characters per second has been added to the medium speed punch of 33 characters per second.

(3) The capacity of the main store available to the programmer has been increased from 4,096 words to 7,168 words; the isolated part of this store, for fixed input/output routines and engineer's routines, has been increased from 1,024 to 2,048 words, making a total store of 9,216 words. The increased size of the isolated part of the store permits a number of extra facilities to assist working with magnetic tape and punched cards.

(4) The first 128 words of the main store are now held on 8-word nickel delay lines instead of the magnetic drum. This enables transfers between the computing store and this part of the main store to be carried out almost immediately without having to wait for the drum to come into position. *Ferranti Ltd.* claim that the new balance of transfers between the two levels of storage is such that one obtains the speed that would result from a large computing store of about 7,000 words at far less cost. This depends probably on the type of work performed. It does not give, for instance, fast random access for the accumulation of data under many cost heads or product codes.

(5) New orders have been introduced to give
   (*a*) Conversion of a number from the 6 bit character mode into the true binary mode.
   (*b*) Conversion of a number from the true binary mode into the 6-bit mode, with the packing of these 6-bit characters into a word.
   (*c*) Conversion of numbers in any radix, e.g. decimal, £ s. d., tons, cwts., lbs., into binary.
   (*d*) Quick assembly of complete numbers from the individual decimal digits on punched paper tape.
   (*e*) Suppression of non-significant (left-hand) zeros—e.g. zero tens-of-shillings.

(6) Closed circuit air cooling with refrigeration is fitted to the computer and power-supply cabinets. It simplifies



PEGASUS Common Language Data-Processing System. PEGASUS 2 with magnetic tapes, high speed paper tape input/output and battery of printers.

the ventilation of the computer room and eliminates much of the noise of the cooling fans.

(7) There is no change in the system of addresses nor in the manner of writing orders, and the speed of existing orders remains the same. Only slight alterations are needed to programs written for the original PEGASUS, and therefore the existing library programs and subroutines are still available.

Representation of Information

Information in PEGASUS 2 is represented in binary digits, but these binary digits can be used in 3 modes, and special functions are provided to allow operations in any of these modes and for conversion between them.

Firstly, the binary digits may be grouped in sixes each representing a letter, number, symbol or controlling instruction for a line printer. A special order is provided to help pack up to 6 of these characters into each word of 39 binary digits and to help extract any character or field for processing.

Secondly, the digits may be used in the ordinary binary modes each word being either one large number or several smaller numbers packed together. All arithmetic is performed in binary, and numerical characters have to be converted to binary if they are to be used in arithmetic operations—this conversion should not be confused with the conversion, on reading cards, from the card code to a computer code.

Thirdly, the binary digits may be used individually for the specialised work of operational research and simulation. The logical orders in PEGASUS 2 help working in this mode.

If *I.B.M.* or *Hollerith* punched card input is required, the card information can be dealt with in two ways. On input each column can, as called for by the program, be either copied exactly as 12 binary digits—one bit for each row on the card—or by passing through special circuits it can be automatically converted into a 6 bit character. There are corresponding arrangements for output. The 12 bits per column method is used for cards punched in non-standard codes, binary cards or data cards already punched from some other computer. The character per column method speeds up conversion from the card and is more usual for data-processing work where a disciplined card-code is adopted, such as 3 zone or 4 zone, and each column represents simply a letter, a number or a symbol. Because either method is under program control some columns of a card can be automatically converted and others copied—this makes it possible to cope with overpunching for 10d and 11d, November and December, designations, and debits.

If *Powers* cards are input, only the 6 bit character method can be used, but special facilities are available for dealing with overpunching. A disciplined code—such as *Powers* 39—must be used, and the codes are converted and automatically packed 6 characters to a word. A single order transfers 48 columns of the card to a block in the computing store, and two such orders can be used to read in the whole card.

Variation of Auxiliary Equipment

With PEGASUS 2 as the basic computer there are three main combinations of auxiliary equipment which can comprise a data-processing system for commercial or technical work. In all of them magnetic tapes are normally used for the bulk storage of file information.

(1) *Common-Language System.* (With magnetic tapes, paper tape input/output and a battery of character printers.)

It relies on punched paper tape as the medium for input of data and output of results with the output tape being subsequently typed out on a battery of 3 to 5 teleprinters or FLEXOWRITERS. Stress is laid on communications by TELEX lines from outstations to the computer centre, and *Ferranti Ltd.* state that they have devised techniques, based on check sums, for dealing with the problem of verification.

(2) *Direct System.* (With card reader, card punch, paper tape, and optional magnetic tape.)

In general, information is taken into the system direct from punched cards or paper tape. Results are brought out on punched cards for printing on a standard tabulator, and extracts or monitoring information are brought out on paper tape to be printed on a teleprinter. Bulk storage of files may be on magnetic tape. It is possible that results can be written on to magnetic tape for printing on an off-line SAMASTRONIC printer.

The card reader runs at 200 cards per minute and the card punch at 100 cards per minute. All 80 columns of a card may be read or punched, each card is read twice and checked before the information is transferred to the computer; after punching, each card is check-read.

Facilities are available or under development for the use of *Powers-Samas*, *Hollerith*, or *I.B.M.* cards.

(3) *Converter System.* (With magnetic tape, paper tape, converter for conversion of punched cards to and from magnetic tape, magnetic tape operated high-speed line printer.)

There is no direct input or output of punched cards, but the off-line facilities mean that card conversion can be proceeding while the computer is carrying on at full speed with other work and printing need not hold up or slow down the central computer. The printer—the *Ferranti* modified BULL machine—operates at 150 lines per minute and has a range of 39 characters, including all letters, numbers, and a selection of other symbols. It is possible to select for printing only certain designated parts of the information recorded on the magnetic tape by the computer. If necessary, the tape can be run through the converter to print the first selection of results, the tape is then rewound and run again with different settings of the controls on the converter console to print the second selection of results, and so on.

Price of Systems

Costs of the data-processing installations range from approximately £55,000 for the basic computer to £180,000 for a complete converter system. Up to 1 April 1959 no PEGASUS 2 had been installed.

* * *

LIST OF MEMBERS

(*List No.* 1, *continued—Ordinary Members admitted to* 30 *April* 1958)

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Editorial

WILL THERE BE SUFFICIENT?

"The difference in the time scale between the action of computers and the human senses is so vast that it is not easy to comprehend all their possibilities in the future. Their speed and flexibility will make them the biggest single factor in process development in the future. The utility of the rapidly increasing number of computers will, however, depend on there being enough people trained to use them and to service them."

So said Sir Harold Hartley, F.R.S., at the symposium in May on instrumentation and computation in process development and plant design. The symposium had been arranged jointly by The British Computer Society, The Institution of Chemical Engineers and The Society of Instrument Technology.

The need for adequate computer staff is true not only for process control but in all uses of computers. How is this staff to be recruited and trained? Our main article in this issue deals with this question and discusses methods of selection. We hope it will raise a certain amount of controversy and lead to correspondence, especially about aptitude tests, from firms who actually do select and train computer personnel.

What part can the British Computer Society play? By its very existence the Society does spread knowledge of computers and raise interest among students of several disciplines. Their Education Committee is already collecting details of the types of courses provided by colleges and universities all over the country—and this may reveal gaps both geographically and by subject. The Education Committee has at times received inquiries concerning carreers in computing, but it does not give advice on a regular basis.

Should the Society develop a service for young people seeking careers in computing, and put them in touch with interested firms? Should they try to persuade colleges to give different courses, or even promote standards through their own examinations? Perhaps, however, members think that all this is outside the province or even the concern of the Society, and that we are deluding ourselves about the influence of the Society.

COMPUTER COMMENT

Serviceability Statistics

Mr. R. S. Gander of Littlewoods Ltd. suggests that statistics of the frequency of punching errors and of computer serviceability would be valuable. If the BCS sets up a standard method of presenting serviceability results, would the manufacturers fall in line?

Russian Journal Translation

BSIRA have produced for DSIR an excellent translation from the Russian of *Instrument Construction*, a monthly journal. It is available at £6 yearly post free from Taylor and Francis Ltd. of London. The January 1959 journal includes a short article on the future of computer engineering in Russia.

Banking by IBM

The Bank of Scotland, in Edinburgh, is making a start in the use of electronic data processing equipment for posting the daily ledger and producing statements. The application does not concern a computer but a single *IBM* 420 accounting machine to which is attached an electronic unit (adapted from the 602 calculator) to calculate interest during ledger posting operations.

Branch transactions are sent daily by messengers to the central machine unit and recorded on punched cards. After bank closing time these cards are used to post the daily ledger—the customer records being kept centrally on a master file of punched cards. A running ledger is not used but instead a separate slip is produced in duplicate for each account on each day a transaction has taken place. The slips are sent to branches ready for the next morning's business, so the branches know the latest balance and the transactions on a customer's account.

During ledger postings on the 420 accounting machine it is possible to calculate and accumulate data for both the interest and the bank charges relative to an account. Statements are produced from the same punched cards in a similar format to that previously received by the customer. The statements are produced in duplicate and one copy is held in the branch to replace the daily ledger slips and to form a permanent record.

The system at the moment has been adopted for only a few branches in Edinburgh, but it may be extended to other branches with communications via TELEX or *IBM* TRANCEIVERS.

Computer Publicity

It is interesting to note that neither the *Ferranti* SIRIUS nor the *Elliott* 802 scientific computers received publicity until they were actually made, working and on show. This is in stark contrast to some commercial data processing systems which are announced in a blaze of publicity years before they are in production and years before even the prototype has been finished. Is there a moral somewhere here concerning the make-up of the relative markets for scientific and commercial computers?

We regret the delay in the publication of this issue due to the dispute in the printing industry.

It is hoped that normal publication dates will be adhered to for subsequent issues but we are unable to program the future course of events.

CORRESPONDENCE

Letters from readers are welcomed, and should be addressed to The Editors, The Computer Bulletin, Finsbury Court, Finsbury Pavement, London, E.C.2. The name and address of the writer must be given, but will not be published if requested.

Computer Delinquency

Sir,

I quote two extracts from the *Daily Express:*

"'*BRAIN' GOES HAYWIRE* *11/4/59*

A new £13,000 'brain'—electronic computer—went wrong at Rosyth, Scotland's naval base, this week, and as a result 2,500 men at the dockyard went payless last night.

The brain was making pay packets like 'five days. 4s. 4d. an hour, less P.A.Y.E., less insurance = £3,600.' Now the accounts staff is working day and night to catch up on the brain's job."

"*COMPUTER TRAPS GIRL CLERK* *4/6/59*

Three fire engines, two police cars, a Black Maria and an ambulance, with 20 firemen and policemen, raced to Hertford Street, Mayfair, last night—to rescue a girl clerk with her fingers trapped in a computing machine.

Someone had heard the girl's cries for help and dialled 999."

These news items give the impression that computers are essentially unreliable or dangerous. It seems to me likely that it would be in the interests of the computing profession if a fuller report were published.

Yours, etc.,

C. R. MERTON

N.R.D.C.,
1 Tilney Street, London, W.1.

* * *

Computer Exhibition

Sir,

As the joint author who was mainly responsible for the tabulation of the details on which our comments were based, I would like to reply to the letter from Mr. A. H. Beaven appearing in your June/July issue.

The data which we collected from the Exhibition was summarised in the table on page 74. The ELLIOTT 405 disc and 402 drum were included in the count of twelve magnetic drums (working) in that table. Unfortunately, in the process of condensing our notes, we did not mention them specifically; it seems we tended in the short time available to highlight the newer developments, overlooking some of those well-proven ones of several years' standing, with which most of our members were already well acquainted.

To avoid possibilities of misunderstanding, particularly among overseas readers, I have now expanded the top few lines of the table to show business systems separately. The division is, however, rather difficult: a scientific computer can be the system centre of a data processing system, and machines built mainly for business applications are, as we all know, used regularly for scientific computing.

Regarding "time-sharing," our understanding of the 802 was based on the leaflet JPP. 2M1158, issued by *Elliott Brothers (London) Limited* and headed "Time-sharing on the NATIONAL-ELLIOTT 802 Computer"; this leaflet was handed to me at Olympia.

"Parallel programming" in the sense used by Dr. S. Gill in his article in *The Computer Journal*, Vol. 1, has been understood, here, to refer primarily to a parallel operation of different parts of the machine during a single job. Punched card tabulators, LEO and the ELLIOTT 405 System have already exploited this feature.

Yours, etc.,

H. W. GEARING

c/o The Metal Box Co. Ltd.,
37 Baker Street, W.1.

The expansion of the first few lines of the table on page 74 of Volume 2 is as follows:

	Working	*Major Assemblies*
Types of Digital Computers:		
In Exhibition		
Business Data Processing Systems	5	4
Scientific Computers	7	1
Available (outside Exhibition) for Calculations		
Business Data Processing Systems	2	–
Scientific Computers	1	–
Shown as models		
Business Systems	–	5
Scientific Computers	–	3
Types of Electronic Calculators (Mainly Business applications)	3	–

SELECTION OF COMPUTER PERSONNEL

by R. M. Paine

Introduction

The use of computers for data processing and scientific applications is now well established—there are about three hundred computers installed or on order in this country and many hundreds more in the U.S.A., the majority of all these for scientific purposes. The selection of personnel for computer installations is already a vital matter in the successful running of computer systems, and with the increasing number of installations due in the next few years it will become a critical problem.

As yet it would be well not to insist rigidly on a division of skills, training, responsibilities and grades, since the available experience does not permit such definite rulings. Flexibility in selection of personnel is still desirable but it is possible to give some helpful indications of the type of staff required. The propositions put forward in this article will mainly apply to commercial data processing rather than to technical or scientific work, and the main emphasis will be on the relatively new skill of programming.

Categories

Computer personnel may be divided into the following five broad classifications:

(*a*) Systems Analysts.
(*b*) Programmers.
(*c*) Operators.
(*d*) Data Preparation Staff.
(*e*) Maintenance Engineers.

The numbers in any category required in an installation will vary according to the type and size of application, scale of equipment, the means of originating data, etc. It should also be remembered that the categories are not necessarily water-tight compartments and that the data processing group will not operate in isolation from the rest of the firm. Bearing this in mind it can be stated that the total staff required for a large computer system with magnetic tape equipment may range between 50 and 75.

Systems Analysts

The systems analysts will play the major part during the survey to decide whether or not to order a computer, in the consideration of the choice of equipment and later on in planning the blueprint of how the computer will fit into the overall data processing procedures. This work is similar to the normal Organisation and Methods investigations carried out by some firms, and O and M staff, often with University backgrounds, have successfully carried out computer feasibility studies. They will, of course, have had the backing and guidance of senior management.

The O and M man selected for computer investigations requires a sound knowledge of data processing equipment and an appreciation of the method and cost of alternative ways of performing the work, i.e. by hand, by keyboard accounting machines, by punched cards. He must be skilled in problem recognition and in sensing the inter-relation of the activities of a firm. He will probably be in the age range of 28 to 40 and have spent some time already looking at the organisation's systems. He should be familiar with accountancy since in much of the work to be put on to a computer he will meet accountancy terms and special accountancy controls.

The systems analyst should know sufficient about programming to be able to communicate with the programmers, and be capable of appreciating their problems arising from a suggested method of approach. It seems from experience that the investigator has need to know more about programming than was originally believed. Although the analyst leads the procedure study, the programmer comes more and more into the picture as the time approaches to place the work on the computer. The systems analyst job is not a "once and for all" one, because all the work is not put on the computer in one mad rush. Jobs are put on the machine successively, and many of them will be inter-related—thus the investigator's task is a continuing one over some years.

The investigator must also possess great qualities of tact and persuasion as he will come up against some very tricky opposition in the course of his work.

There already exists some basis for the selection of the systems analysts—such as in the recruitment for O and M departments or in investigators for punched card firms—and therefore the problem is not as novel or as great as in the case of programmers.

Programming Staff

Programmers are concerned with the detailed planning of work for a specific system that has already been ordered, and in translating the agreed procedures into machine language by means of coding. Before actual coding and testing starts, programmers have to determine the new system in co-operation with the systems men and clarify it in detail by means of flow charts. The exact responsibilities of programmers do vary from firm to firm, and there are several grades.

The author does not believe that this task can satisfactorily be broken down into two stages by using junior labour for the actual coding—the concept of specification, flow charts, coding and testing, calls for one person to carry out the whole.

What ability is required in a programmer? He or she must understand and follow how the computer tackles a job step by step; therefore he, or she, needs meticulous attention to detail. A logical approach to problems is

more useful than sudden flights of imagination and fancy. Patience and curiosity about how patterns fit together are worth more than a very high intellect which is impatient or becomes bored with trivial matters. A good level of education is an asset but graduates do not necessarily make the best programmers. Programming for commercial work does not essentially require mathematicians, but a knowledge of office methods and commercial jargon is essential. Too highly skilled people performing the work may become bored after a year or two while other people derive continual creative satisfaction from the work. The ability is not confined to men, and some women make excellent programmers. Programming seems to be a relatively youthful ability, most people starting when they are under 30. Programming ability does not appear to belong to people of any particular background which makes tests for the skill all the more difficult. Graduates in Economics, History, Statistics, French, Archeology, Mathematics and Physics have all made good programmers, as well as many people who are not graduates at all.

These few scattered observations emphasise the difficulty of selection, and we can now consider how selection is made in various firms and government organisations. There are probably four approaches, none of which is entirely reliable on its own, which means that most organisations use two or three of them as cross-checks. The four approaches are:

(*a*) Aptitude Tests.

(*b*) Performance on a Training Course.

(*c*) Past History and Experience.

(*d*) Interview.

Aptitude Tests

Aptitude Tests have probably been used more in America than in the United Kingdom, but the difficulty is in knowing what type of person or what qualities you require and then designing a test to highlight the desired qualities. Some firms feel that once a person has taken one aptitude test he will quickly adapt himself to others without necessarily possessing the qualities required. Other organisations say that tests are difficult to keep secret, and if they become known the candidate is preconditioned and liable to pass easily. One or two companies believe they have designed excellent tests which consequent experience has proved to have selected successful programmers—but these firms will not publish the tests to help other organisations since they want to keep them secret. These attitudes seem to indicate that new tests are continually required to keep them fresh and unknown to the candidate.

Tests have been devised by the Research Unit of the Civil Service Commission and are used for entrants to government posts—but it is said to be too early yet to judge their effectiveness. I.B.M. (United Kingdom) Ltd. give aptitude tests to their own programmers and then correlate later performance with the results of the test. The test itself is not apparently used for outright rejection, but if a candidate scores a very low mark he is very critically examined before acceptance as a programmer. In general, however, even if all candidates passed by an aptitude test turn out to be good programmers, it does not prove that some of those rejected on the basis of the test would not have been as good or even better programmers. This seems a serious drawback to selecting only by means of aptitude tests.

The Systems Development Corporation in the U.S.A., employs about 800 programmers on the SAGE system of Air Defence. It used a battery of psychological tests as part of its recruiting procedure, and details of this "battery" are given by T. C. Rowan(1). It is said that Thurstone Primary Mental Abilities Test and the Thurstone Temperament Schedule could be used to predict success on the job. These tests involved sub-tests for Verbal Meaning, Reasoning, Space and Emotional Stability. The first two sub-tests are designed to measure aspects of general intelligence—in the "Verbal Meaning" test the candidate has to choose the closest synonym to a given word from a group of alternatives, and in the "Reasoning" test the candidate has to complete a sequence of numbers, i.e. what is the next number in the series. Other types measure the ability of a candidate to correlate shapes and patterns. The contents of this "battery" are fairly typical of aptitude tests in general.

The Systems Development Corporation state the entire procedure of selection is constantly under study and "while the psychological test may appear to be the focal point of examination, it is important that the entire process of recruiting, selection and training be given an objective assessment with careful consideration being given to all aspects."(2)

Some firms have given aptitude tests to existing programmers on their staff. A danger of strong correlation here is that performance at the tests may be good because of the training and experience gained by the programmers. The correlation, therefore, would not be useful or significant in determining whether the tests should be used to select staff. One is seeking for a latent quality in raw recruits.

It is interesting to note, however, that when "The Rand Corporation"(1) were wanting to design new tests for selection they decided to take an independent rating of many existing programmers, then arrange for them to take the new tests and finally to see if there was any correlation. In some groups the programmers' supervisor was asked to rate his section and to distinguish between technical ability, experience and over-all effectiveness. In other groups the programmers were asked to rate each other. Unfortunately it turned out that the correlation between the results in the new aptitude tests and the ratings were not significantly different from zero. This at least enabled them to eliminate the new tests and revert to the existing tests for programmer selection. It seems very difficult, therefore, to devise means of unearthing the latent talent.

A properly administered test, however, can give better

help than mere ability at chess or bridge or a trait of absent-mindedness. These have not yet been fully checked with programming ability, although many programmers show some of these symptoms, especially the last.

Psychological tests for personnel selection have of course been used in other fields and at times their claims have been oversold; tests designed for one purpose were foolishly used for other purposes; and they have somewhat naïvely been expected to solve all recruitment problems. It is to be hoped that this will not happen to developing aptitude tests for computer personnel. At the moment aptitude tests by themselves are not sufficient since we do not really know for what we are testing and we are not sure what pass level to set. They are useful, however, to weed out non-starters and perhaps for correlation later with the results of experienced programmers in order to design better tests.

Training Courses and other Selection Methods

Another selection method is to send candidates on a two-week programming course, probably run by a computer manufacturer. On the results of their performance you can probably gain a good idea of whether they would respond to further training or not. This approach seems possible if the selection is to be made from present employees who can be returned to their previous jobs or perhaps to other positions if they do not make the grade as programmers. Even so the position would have to be carefully explained to existing employees so that they do not become disheartened if they do not succeed, and only volunteers should be taken.

This approach is more difficult if outside recruitment is necessary since it means they will be employed for a short while and then if unsuccessful dropped. A few might be moved to other jobs in the company but that way is limited. Performance on a course, however, does seem at present to be a better method, though more costly, of predicting a future programmer than aptitude tests by themselves. A course does not make a trained programmer since this takes months of experience on the job, but it does help to indicate who might succeed.

The selection method of examining past history and experience is limited in this early stage of computer usage since not many people will have had computer experience, and it is not yet the job of the universities to train students in programming or other computer expertise. Still, a fairly high level of education, and especially of intensity of application to work, should be looked for, together with some experience in business and perhaps punched card knowledge. This later may be a snare since the approach is different and a plugboard genius may be a code-sheet duffer. One should beware of some people who say they have computer experience since it is rumoured that in America some programmers are repeatedly lured away by attractive offers from one firm to another without ever completing a program!

This method is normally combined with an interview where one assesses the candidate's personality and examines his performance in his previous jobs. If recruitment is from inside the firm it is probably easier to discover these points—for otherwise a single interview can be very misleading. Careful questioning may reveal in the candidate that curiosity of mind which is so important a criterion for program construction.

Many programmers have certain eccentricities, and while it is not suggested that selection should be by eccentricity, it is suggested that one should not be put off if a candidate does seem to have certain quirks not normally associated with standard commercial staff. The programmer will not normally be doing routine work so one should not look for the "routine" mind. Some observers have called programmers "harmless drudges," but this is probably because they were very wrapped up in their jobs—it does not mean they are not lively and intelligent.

Grading and Salaries

Companies often require some guidance on the grading and salaries of programmers, and this is again a field where there is a wide divergence of views. Practice differs from firm to firm, and between scientific and commercial applications—the scientific applications normally calling for greater experience and qualifications in the specific subject to be tackled such as physics, mathematics or engineering. For commercial work the government departments tend to class the job as Executive Officer to Senior Executive Officer—they do not create a specialist grade.(3) In business the salaries seem to range between £700 and £1,500 depending on age, sex, experience, qualifications and ability. Many programmers, however, will not remain at the job all their lives but, like some systems analysts, will move into other positions in the firm. There is always the exception, though, who becomes chief programmer or even computer manager.

Operators

The third category of staff to be considered, the operators, do not normally take part in any investigations, but they are required before the computer is actually installed so that they can be well trained. There are various duties that have to be performed, and operators tend to specialise on one or two of the jobs. The work includes operation of the computer console during test and production runs, taking the initial action on any stoppage or breakdown, feeding and removing magnetic tape, paper tape and punched cards, looking after the printer and being responsible for card and tape files.

This work requires sound common sense and the ability to understand the significance of what is being done in relation to the rest of the installation—because installations can be drastically affected by inefficient labelling

of files or slack use of console keys. The console operator will probably require some knowledge of programming, and possess the ability to communicate with programmers, especially on test runs. He will also have to get on well with the engineers and know when and when not to call for their assistance. The operators of the auxiliary machines need mainly manipulative skills and tidy methods. These jobs are very similar to those carried out by the best and most alert operators in a punched card machine room, though the console operator is probably of a higher calibre. Special training will of course be given to all classes of operators.

There seems at present no difficulty in recruiting this grade of staff and women are used for most of the posts. Interviews and past records seem adequate selection methods though aptitude tests are also sometimes used. The standard of education will vary but will be well below graduate level normally, and character, quickness and neatness will count for more than academic ability. Leo Computers believe the console operator should have G.C.E. Advanced Level in three subjects and display a capacity for initiative.(4)

Data Preparation Staff

The Data Preparation Staff will normally be the largest category in any installation—though much effort is now being given to character recognition and other automatic means of recording and input to the computer system.

Data preparation, at present, means the punching and verification of information from documents into punched cards, paper tape or even magnetic tape in a few instances. The same process exists in conventional punched-card installations, and computers do not really raise any new problems except a higher insistence on accurate transcription to save the waste of valuable computer time. The staff employed on data preparation are nearly always girls and there is a large labour turnover due to natural causes. The work is dull to most intelligent or ambitious people, but demands fairly rigorous concentration. Thus the girls must be industrious and tidy but do not require sixth form educational standards.

Their selection is normally by interview and some means of a simple test to measure their manual dexterity. To draw the best out of this staff, good supervision is required, a sense of teamwork and perhaps even an incentive scheme. In some firms where both computers and a conventional punched card installation exist, it seems that the better key punch operators are used in the computer installation thus forming some ladder of promotion.

Maintenance Engineers

Maintenance Engineers are very important staff on an installation but surprisingly they seem to raise little selection problem for computer users. This is because they are generally provided on contract or under a rental agreement by the computer manufacturer. The term maintenance engineer covers several grades from the graduate engineer to the ex-radar mechanic, and normally there are one or two people resident at the installation.

Some manufacturers appoint the engineer to the computer while it is being built and he stays with it during its life and thus learns it thoroughly and understands its idiosyncracies. The maintenance engineer is an important member of the computer team since he carries out preventive maintenance, probably daily, thus allowing the computer long production runs; and in the case of breakdowns, he diagnoses the trouble swiftly so as to reduce loss of production to a minimum.

Some companies such as Unilever Ltd. are now employing their own maintenance staff, but they usually send them to a manufacturer for training. The type of candidate is either someone who has just finished National Service and holds the G.C.E. advanced certificate in mathematics and physics, or an older person, though still under 30, who is a qualified electronic engineer with Higher National Certificate or a degree. Leo Computers run two training courses for their own maintenance engineers.(4) The Preliminary Engineering Course lasts thirteen weeks and covers the theoretical and practical aspects of alternating currents, thermionics and valve circuitry. The Computer Engineering Course lasts sixteen weeks and deals with the logic of the computer, its output and output systems, the power supplies, the auxiliary equipment and the theory of programming. Thus although an engineer may already be a trained man when selected, he has to learn a great deal more about the computer side of electronics.

Conclusion

The selection of computer personnel is not as difficult as might be thought at first glance. The greatest difficulty will probably be in deciding whether a candidate will make a good programmer—for it is costly to train extensively someone who will not make the grade.

The ultimate responsibility for staff selection must rest with management, and they must be prepared to invest time, thought and money in the recruitment of suitable computer staff. For the success of a well-run computer system depends not just on the machine itself, but mainly on the people running the system.

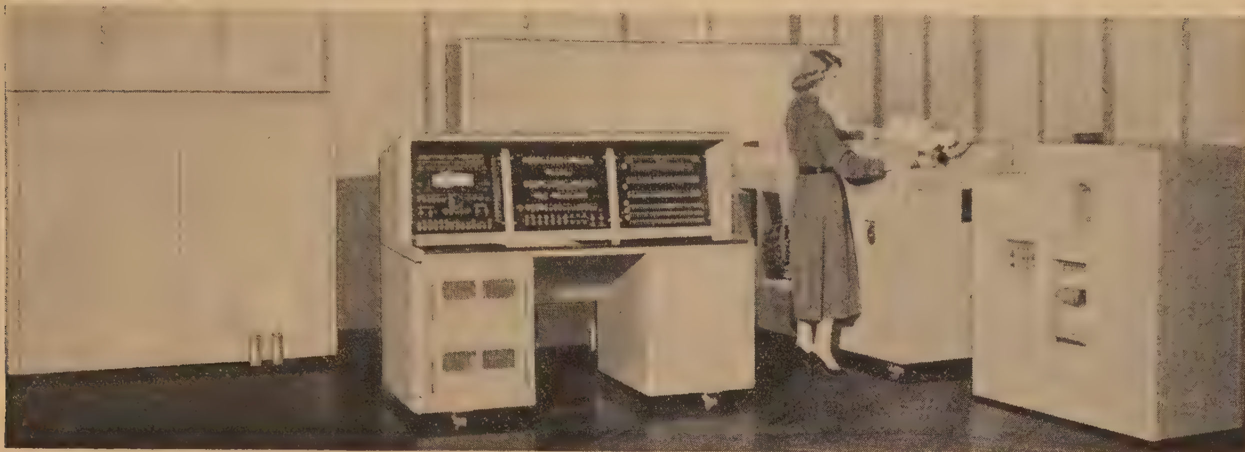
* * *

References

1. T. C. Rowan. *Journal of the Association for Computing Machinery*, Vol. 4, 1957 (pp. 348–353).
2. *Datamation*, May/June 1958, pp. 16–18.
3. G. H. S. Jordan. *O & M Bulletin*, Vol. 14, No. 1, February 1959 (p. 21).
4. *Opportunity*, July/August 1958.

BUSINESS EFFICIENCY EXHIBITION

(By Our Special Correspondent)



The ICT General Purpose Computer Type 1202

This year's Business Efficiency Exhibition, from 25 May to 4 June, the 46th to be held in London, again proved of some advantage in assembling under one roof a range of equipment which would have taken far longer to see at each manufacturer's showroom. In the electronic data-processing field, however, the picture was far from complete. With exhibition of products limited to member firms of the *Office Appliance and Business Equipment Trades Association*, computer manufacturer members of the *Electronic Engineering Association* who have not also joined OABETA were conspicuous by their absence.

While it is true that OABETA have never refused membership to any manufacturer whose products are closely associated with office systems, it is perhaps understandable that many EEA members felt that the BEE followed so soon after the Computer Exhibition at the end of last year that they had nothing new to make it worth their while exhibiting. It is open to debate whether some modest representation, even if only sufficient (by way of a small enquiry bureau, for example) to show there *are* some other computer manufacturers, would not have helped to give a more balanced view of the electronic data processing field.

It was strange, for example, to find *EMI* and *Standard Telephones and Cables* only exhibiting oral communication and recording equipment; representatives on these stands did not seem to know that their companies also manufactured electronic computers—surely of much greater potential for "Business Efficiency" than a pocket dictating machine or a gaily coloured intercom, even if the former (according to another manufacturer) now embodies printed circuits . . . in a new finish . . . proof against hot tea and salt water. As your correspondent dislikes tea and has not the figure for skin-diving, he rapidly concluded that this was not an exhibition to which those knowledgeable in the field of electronic data-processing should pilot senior executives to obtain a quick grasp of potentialities, but concentrated on the new items of interest.

Here it was all too evident that many firms are trying to jump on the band-wagon and claim some connection with the magic word "computer." It is surely undignified, to say the least, when an otherwise reputable manufacturer hooks an electric multiplier to a keyboard accounting machine and calls the result a computer. Another manufacturer, with a slightly more comprehensive calculator linked to a similar machine, claims "unlimited programming flexibility" for the so-called "computer." Exhibitors generally seemed to take the view that, after all, every office procedure is "data-processing"; if any two machines can be linked then the combination is IDP; if any part of a machine has electronic circuitry then this is EDP. So that a manufacturer of, say, a steel filing cabinet which could be used to house a card which could be used in an electronic calculator which could be a part of a data-processing system, however simple, manages to get his name in the catalogue under the sub-section "Punched Card Equipment" of the main section "Electronics." This actual example was by no means an isolated one.

The word "new" was also over-worked; much equipment so designated had already been exhibited at the Computer Exhibition or by invitation to the manufacturer's showroom. This catchpenny salesmanship only serves to delude the ignorant into thinking that the computer, and its logical development in commercial data-processing, is just another office machine that can be ordered and installed as easily as a card index system.

The Business Efficiency Exhibition is now to become

an annual affair in London, in addition to the periodic regional exhibitions in other centres. If future shows are to include computers and electronic data-processing techniques, let us hope that the range of exhibits and information will be more representative of those manufacturers who are firmly in the market for "commercial" applications; the continued absence of important contenders can only give rise to doubts as to the validity of the claim that the exhibition was made "as comprehensive a display as human ingenuity and the space available permit."

Among the more important exhibits, *IBM* showed their 628 magnetic core calculator. Linked to a 565 read/punch unit and a 421 accounting machine, the combined units give a reasonably comprehensive data processing system between the 604 calculator and the 650 computer; it could well be called a computer in comparison with the PCC, for example.

First of the small machines to use core storage, the calculator is fast enough to allow a fairly long process to be carried out within the 421's cycle of reading and printing 150 cards per minute. Examples of calculation times are 180 microseconds for addition without change of sign, or 12 milliseconds for 8 × 8 multiplication with a 16-digit product. There is magnetic core storage capacity of 320 digits, and each 8-position storage unit can be split into two parts, one of three digits and sign, the other of five digits and sign. In addition to the wired program of 160 steps, there is a built-in skip function to any point in the program, ten selectors which can be picked up at any point in the program to control subsequent steps, and ten "and-gate" switches.

When used with the 565 and 421, the 30 three-position selectors on the former are available to control calculations according to card type, while the additional counters, storage units, selectors and program unit of the 421 accounting machine can also be called into use. An illustration of the complete system is given on p. 29.

The other new item shown by *IBM* for the first time in this country was the 610 computer, a small scientific machine for desk-side use by scientists and engineers. Essentially, it allows the user to work through a calculation by step-by-step entry into a small keyboard; at the same time, the machine is setting-up the program for repetitive calculation on new values of variables. Decimal point positioning is automatic, and the use of a range of common built-in functions, coded on the keyboard, avoids programming in the usual sense. Calculation steps are recorded in punched paper tape by the computer for repetitive use, printed results as required being read out on an electric typewriter.

Chief interest on the *ICT* stand centred on the 1202 computer, which supersedes the 1201. Main improvements are an increased capacity on magnetic drum (4,096 words of 40 binary digits on 256 tracks), 100 line per minute printer of 100 alpha/numeric characters (up to 64 of which may be direct decimal digits from the computer) and an improved card reader with automatic conversion into binary. This latter feature gives more flexibility to card format, as cards may be punched in denary or binary, or partly in each, giving greater card capacity. Data can be read at any or all of three sensing stations, up to a maximum of any 64 columns at each; 24 to 64 storage positions are available for direct transfer or alpha/numeric information to the output punch or printer without passing through the arithmetic unit and occupying time. An illustration of the machine is given at the head of this report.

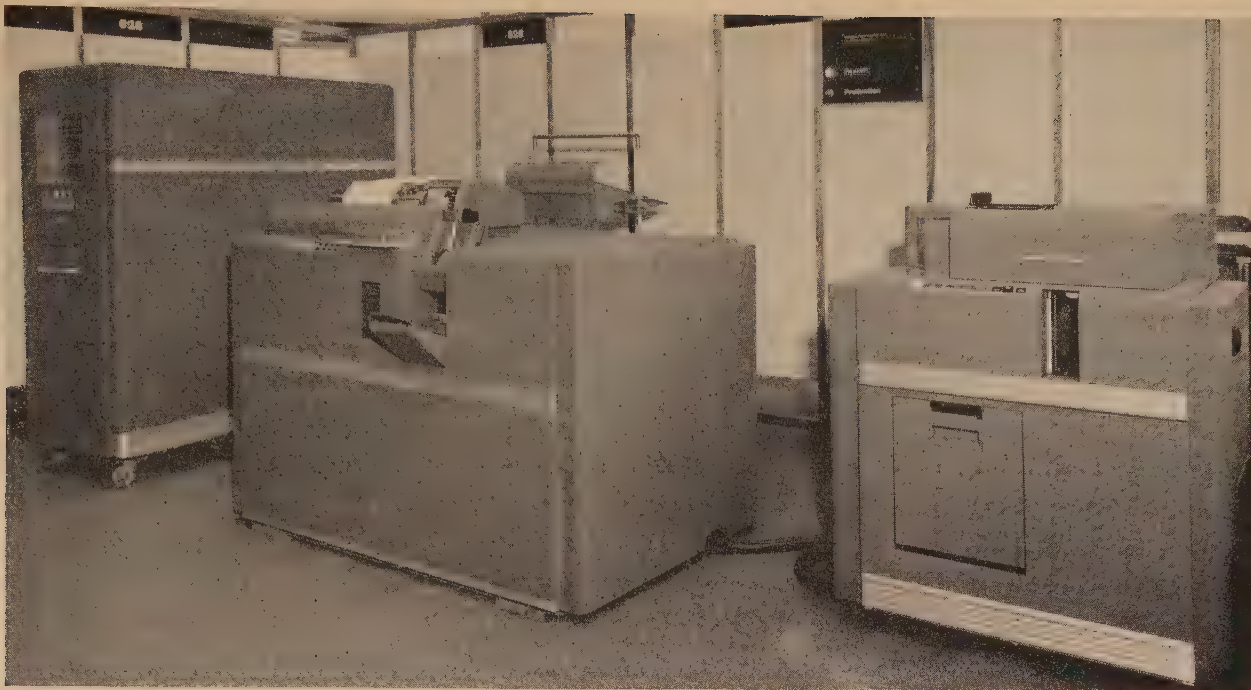
Some of the other exhibits on this stand showed the first results of the merger of HOLLERITH and POWERS into *International Computers and Tabulators*, additional to the *ICT* losenge which now adorns all the familiar Hollerith and Powers range. For example, a HOLLERITH sorter has been modified to accept either type of card; a variable column selector assists the operator (having loaded in the usual way, face up or face down, that she is accustomed to, and set the scale to the variety being sorted) to select the appropriate column. A similar device is being fitted to other HOLLERITH equipment, which would seem to indicate that *ICT* has settled, at least in the 80-column range, for brush sensing; no 80-column POWERS equipment appeared to have been modified to accept HOLLERITH cards.

Burroughs showed the E101 (advertised as "new" although exhibited before) and the F2000 accounting machine with built-in calculator (claimed to be a computer). Of immediate interest was a card punch linked to a SENSIMATIC accounting machine. Although the card is punched serially across the columns in the order of SENSIMATIC operation, some flexibility of layout is given by the latter being "programmed" to suit the card rather than the reverse, using the automatic features of carriage movement of the accounting machine to select the appropriate column of the printed form so that the printing sequence is best suited to the punching sequence. Carried to extremes, the consequent to and fro movement of the SENSIMATIC can appreciably slow down the posting operation, but a reasonable compromise should be possible in most applications.

Information was also available on the BURROUGHS 220 computer system; it is understood that this data-processing equipment will shortly be available in this country. The machine is claimed to be some 10 to 25 times faster than machines currently available in the same price range.

The NATIONAL-ELLIOTT 405 and small 802 had already been shown. Details were available of the 803, a version of the 802 desk digital computer with larger storage and other features. The magnetic core store has been expanded from 1,020 words of 33 binary digits to 4,096 words of 39 digits, the longer word length allowing for the greater number of addresses in the two orders of the single-address code. Slightly slower in operating speeds, a significant feature of the machine is the reduction by more than half in the power requirements.

National also showed a card punch linked to a Class 31



The IBM 628 magnetic core calculator (left), with a 421 accounting machine and 565 read/punch unit, on the exhibition stand

accounting machine. As with the *Burroughs* link-up, the card is serially punched and flexibility in layout must be found from the versatility of the accounting machine, with similar limitations.

Some preliminary details were available from *Remington Rand* of the UCT (Univac Calculating Tabulator). This junior UNIVAC system will be available in this country with the necessary spares and service facilities. A detailed case study is now being made of the installation in the Dresdner Bank, Hamburg, where the printed output requirement is heavy and typical of the sort of commercial application for which the UCT was planned. Installation of the machine and operation of the first two applications took ten weeks only, after which the system was running at 98 per cent reliability. Operating speed has been found to be 200 cards per minute, including handling and loading.

Most of the auxiliary equipment was reviewed in these columns at the time of the Computer Exhibition. There are further glimpses of intelligence in the development of reeling and filing devices for punched paper tape, in the design of racks for storing program boards and panels, and in devising automatic equipment for feeding, cutting and folding paper. But there is a sickening tendency for "efficiency" and "electronic" to become synonymous, and for the principal exhibit on each stand to drag in some computer association. For did you not see the posture chair for the console operator, adjustable in three dimensions? Were you not shown the visible strip index for accurately coding the computer input? Did you not appreciate the claim of one manufacturer, whose electronic device linked a typewriter, adding machine and tape reader and punch, that this "electronic brain insures [*sic*] accuracy"? Then clearly you should equip yourself with a pair of magic gloves, illustrated in one brochure with flashing lights and real sparks. As Olympus was the abode of the gods, so Olympia begets a new mythology.

SOCIETY AND COUNCIL NOTES

Annual General Meeting

A Brains Trust will be held when the business of this year's Annual General Meeting has been completed. This meeting will take place on Thursday 17 September at 6.30 p.m. The following members of Council have agreed to act as the panel of experts:

Dr. S. Gill	Dr. A. S. Douglas
Mr. D. W. Hooper	Mr. R. L. Michaelson.

* * *

Membership

At the end of the Society's second year, membership has reached 1,900. It is expected that 1959–60 will see a steady increase as the branches formed last year extend their activities and local influence. Additionally, there are several hundred subscribers to the Society's publications, mostly overseas, and particularly in the United States; other readers live in China, Australia, U.S.S.R., France, Canada and 24 other countries.

* * *

Income Tax Relief

The Commissioners of Inland Revenue have approved the Society for the purposes of Section 16, Finance Act, 1958; the whole annual subscriptions of a member now qualifies for relief from United Kingdom income tax under Schedule E, subject to the provisions of the act.

* * *

Publications

New members of the Society joining after 1 May 1959 may obtain back numbers of the Society's publications at the following reduced rates:

The Computer Journal, Volume 1 (1958–59), four issues	£2 0 0
The Computer Bulletin, Volume 1 (1957–58), six issues	10 0
Volume 2 (1958–59), six issues	10 0

* * *

International Federation of Computer Societies

The Society has been asked to represent the British Conference on Automation and Computation (Group B) on the newly formed International Federation of Computer Societies (IFAC), and Council have accepted this request.

* * *

B.C.S. at Cambridge

As we go to press, the British Computer Society's First Conference is assembling at Cambridge and, before this issue is published, will have passed into history. The many distinguished visitors from overseas will have returned to their home countries, delegates will have resumed their daily occupations or gone on their summer holidays, and EDSAC 2 will doubtless sigh with relief at the successful conclusion of yet another series of demonstrations.

Judging by the final programme, by the numbers of delegates (exceeding the original capacity limit), by the overseas entry and by the press and radio interest, the conference will be an unparalleled opportunity in this country for worthwhile study and exchange of information on a most varied range of subjects in the field of computer technology and data processing.

A detailed summary of the conference will be given in our next issue, and many of the papers and other contributions will be published in these columns or in *The Computer Journal.*

* * *

Winter Programme

Details of the winter programme of monthly meetings are expected to be issued to members before the end of August. A joint symposium on computer maintenance with the Institution of Electrical Engineers is being planned for January 1960.

* * *

Library of British Computer Society

The nucleus of a library of the British Computer Society is now housed at the Leicester College of Technology and Commerce, whose Chief Librarian is the Society's Honorary Librarian. The publications listed below are now available for consultation on loan, and additions will be notified in the *Bulletin*. The Honorary Librarian would welcome gifts of any material likely to increase the value of the library to members.

Will members in the United Kingdom wishing to borrow material by post please write to F. C. Adey, F.L.A., Honorary Librarian, The British Computer Society Limited, c/o Leicester College of Technology and Commerce, Leicester.

PUBLICATIONS

Accounting and Office Management

Accountancy
Accountant
Accountants Magazine
Accounting Research
Local Government Finance
Management Science (New York)
Office Equipment Industry
Office Management
The Secretary

Computers Abroad

ACM Communications (New York)
ACM Journal (New York)
Chiffres (Paris)
Computer Bulletin of South Africa (Johannesburg)
Computing News (Seattle)
Controllership Foundation (New York): Business Electronics Reference Guide, Volume 4
— material to 31 January 1958 = *Last* of series of guides to electronics in business
Datamation (New York)
Data Processing Digest

Education

Aslib Proceedings
Bulletin of Special Courses in Higher Technology
Journal of Documentation

Engineering

Aeronautical Quarterly
British Institute of Radio Engineers Journal
Chartered Mechanical Engineer
Institute of Electrical Engineers Proceedings, Part B
Institute of Petroleum Journal
Institute of Petroleum Review

General

Automatic Data Processing
BCAC Bulletin
Data Processing

* * *

Alteration in Society's Memorandum

At an Extraordinary General Meeting of The British Computer Society Limited, held at Northampton College of Advanced Technology, St. John Street, London, on 17 February, a Special Resolution was passed to amend the provisions of Clause 3 of the Memorandum of Association. Certain changes in the objects of the Society were necessary for the Society to secure exemption from taxation, but these changes do not fundamentally change the purposes for which the Society was originally formed.

The Special Resolution, which was carried without dissent, covered changes in four of the objects, the clause now reading as follows, the altered sentences being shown in italics:

"The objects for which the Society is established are

(*a*) To take over the whole or such part as it may lawfully take over of the real and personal property belonging to, and to undertake all or any of the liabilities of, an unincorporated association known as "The British Computer Society," whose principal office is now situate at (etc.).

(*b*) To *promote knowledge of* the development and use of computational machinery and techniques related thereto.

(*c*) To facilitate the exchange of information and views on computational machinery and techniques related thereto, and to inform public opinion on the subject.

(*d*) To hold or to participate in the holding of conferences and meetings for the reading of papers and the delivery of lectures, and for the acquisition and dissemination by other means of useful information concerning computational machinery and techniques related thereto in the United Kingdom and other countries.

(*e*) Subject to the provisions of Section 14 of the Companies Act 1948, to purchase or lease, rent, hold or dispose of any buildings to be used as a College, Library, Offices or Lecture Rooms, or any other property, real or personal, for the advancement of the above objects, or any of them. (*The words originally following, "or which may be deemed necessary or convenient for any of the purposes of the Society," are now omitted.*)

(*f*) To take any gift of property, whether subject to any special trust or not, with a view to furthering directly or indirectly any one or more of the objects of the Society.

(*g*) To borrow or raise any money that may be required by the Society upon such terms as may be deemed advisable, and in particular by mortgage or charge of all or any part of the property of the Society.

(*h*) To form a library or libraries and one or more collections of equipment for the use of members, and to collect, collate and publish information of service and/or interest to members *and others*, by printing and publishing, or assisting in the publication of, any newspapers, periodicals, journals, books, circulars or leaflets that the Society may think desirable for the promotion of *knowledge of computational machinery and techniques related thereto.*

(*i*) To contribute to the expenses of *persons* attending conferences or meetings on behalf of the Society or engaging in travel or research at the request of the Council to promote the objects of the Society.

(The rest of the clause contains the normal financial provisions and provisos common to most companies limited by guarantee.)

LONDON MEETINGS

There were three meetings held in April. In one of these the Society was privileged to hear Professor Lancelot Hogben, F.R.S. (well known as the author of *Mathematics for the Million* and *Science for the Citizen*) express some opinions on present day trends in *The Mechanical Translation of Languages*. It is generally agreed that there is a real need to simplify the exchange of information on an international scale. Professor Hogben believed that whilst mechanical translation has already yielded promising results, there were still some difficult problems ahead before these techniques could be applied in the widest context. He expressed the opinion that the proponents of mechanical language translation had over-simplified these difficulties. Apart from his criticisms of these techniques, he suggested that the same ends could be met by the creation of a second and more precise language, an interlingua, which ideally would be internationally accepted and used. This is politically impossible in this day and age but something might be done by the creation of national interlingua. It seems likely that the precision of these interlingua could also simplify their mechanical translation. Professor Hogben was in fact working along these lines.

In a May meeting Mr. R. L. Cooke (*Elliott-Automation*) dealt with the new 802 solid state computer. Mr. Cooke explained why his firm had gone ahead with the manufacture of this small and relatively slow machine (as compared with their 400 series). Although it stands as a general purpose computer in its own right, it was primarily intended to be used "on line" in a process control system. To do this it was necessary to have means of automatically monitoring the various sources of information, and thus to undertake whatever data processing was necessary and to print or punch the results. As the machine was in effect dealing with several programs (one program for each monitored station), it is necessary to assign priorities to programs; that is, to time share the computer according to its current needs. A simple and perfectly satisfactory method has been devised for this purpose, and was described by Mr. Cooke. Although Mr. Cooke was reluctant to get involved in any engineering aspects, he said enough to show that there is every reason to expect a significant step forward in the reliability of computers using transistors and cores.

Mr. T. C. Hickman (*Unilever Ltd.*) gave a very interesting talk entitled "Early Experiences with an E.D.P. System" on 12 May at the Northampton College of Advanced Technology. Mr. Hickman said that Unilever had approached the purchase of the computer (a NATIONAL-ELLIOT 405) in a spirit of research and had realised that the machine would not pay for itself for at least three years.

Unilever had not tried to place one large paying job on the 405 but had tried out a variety of applications in order to gain experience of many different problems. The work placed on the computer had included payroll, sales analysis, buying and transport problems, and had ranged from conventional data processing to the use of statistical and scientific techniques.

Mr. Hickman said he was puzzled why it was that, in many firms, if a research project was undertaken on the production side, it was allowed to establish itself under select conditions away from the shop floor and then slowly move into actual production conditions; whereas on the office side a research project, like a computer, was expected to enter from the very beginning the hurly-burly of the office and produce results straight away.

Unilever had paid great attention to the education of the staff, especially management, and had organised several courses. Mr. Hickman claimed these were very useful in gaining acceptance for the idea of a computer and several managers who had attended courses had since suggested jobs for the computer.

Mr. Hickman also showed a very amusing and instructive colour film "The Electronic Computer in Commerce" made for Unilever Ltd. by *Rayant Pictures Ltd.* This included some very fine shots of a street market where the traders had all their business facts at their finger tips and consequently did not need a computer. This film will shortly be available in 16 mm. and 35 mm. versions to other firms free of charge and should make a useful introduction to computers.

The full text of Mr. Hickman's lecture will be printed in a forthcoming edition of *The Computer Journal*.

U.N.E.S.C.O.—Information Processing

The international conference on information processing, sponsored by UNESCO, was held in Paris from 15 to 20 June. The Society's President, Dr. M. V. Wilkes, was the opening speaker at the sessions on the logical design of digital computers. Other speakers in this section were C. Strachey, on time sharing in large fast computers, and G. C. Tootill, on the use of cyclic permuted chain codes for digitisers.

In the section covering methods of digital computing, papers were given on the solution of elliptic difference equations by stationary iterative processes, by D. J. Evans, and on rounding errors in algebraic processes, by J. H. Wilkinson, who was also the co-ordinator at the symposium on methods for solving linear systems.

Other speakers from the United Kingdom included F. G. Duncan and E. N. Hawkins (pseudo-code translation on multi-level storage machines), T. Kilburn, R. L. Grimsdale and F. H. Sumner (experiments in machine learning and thinking), and A. F. Parker-Rhodes and R. M. Needham (a reduction method for non-arithmetic data, and its application to Thesauric translation). S. Vadja was the co-ordinator at the symposium on linear programming.

REGIONAL BRANCH NEWS

HULL

The Annual General Meeting was held on 15 April 1959. Membership of the Branch had increased from an initial membership of 8 to 26. Meetings in the past year had covered a wide range of subjects in scientific and business fields. The highest attendance had been 170 at the inaugural meeting addressed by Mr. A. J. Barnard, the City Treasurer of Norwich. At Scientific meetings attendance had averaged 20 and at "Commercial Topic" meetings had averaged 50. Subjects had included "Mechanical Translating of Languages" and "Order Invoicing Application of Computers in Industry."

Visits had been made to the *Blackburn & General Aircraft Co. Ltd.*, Brough, to inspect their PEGASUS installation and to the City Treasurer's Department of the Kingston-upon-Hull Corporation to inspect their HOLLERITH installation.

Dr. A. King, the newly-elected Chairman, said that his first action was to state his personal appreciation and thanks to Mr. P. J. Lown for the excellent way in which he had, as past Chairman, conducted the affairs of the Branch.

The Annual General Meeting was followed by an address by Dr. K. Tocher (*United Steel Corporation*) on the subject "Operational Research in Industry."

* * *

LEICESTER

The Annual General Meeting of the Branch was held at the Leicester College of Technology and Commerce on 5 May. The Secretary, A. E. Richards, noted in his report the steady increase of membership during the year. Dr. P. G. Wakely (*English Electric Limited*) was elected Chairman for the next year.

On 21 May, members visited *Stewarts & Lloyds Limited* at Corby to see the LEO installation. Mr. J. L. Clark welcomed the party. After seeing a short explanatory film, members inspected the computer. The payroll program was demonstrated as well as off-line processes. Mr. N. C. Pollock's earlier talk to the branch had prepared members for the visit, but the opportunity to inspect the machine itself in its building, designed for the purpose, was greatly appreciated.

* * *

NEWCASTLE

On 5 May Dr. K. D. Tocher addressed members and their guests on the topic Operational Research. Introducing the speaker, Dr. Page pointed out that Dr. Tocher had been a lecturer in Statistics and had designed and constructed an automatic computer but had deserted academic life to join the Department of Operational Research and Cybernetics at the *United Steel Company* at Sheffield, where they have a PEGASUS computer. Dr. Tocher felt that the title of his talk was far too wide in its scope, and he restricted himself to the general computer simulation of an organisation similar to a Steel Works. The model, which can be applied in a great many factories, consists of a series of "machines" which perform certain specified operations. At any instant of time, certain "machines" are "active" (i.e. actually performing operations) while other "machines" are lying idle, usually awaiting material for which other operations must be completed first. Thus "machines" are either "active" or "idle" and the interesting "events" occur when a specific operation is completed. At this stage some "machines" become idle, and are therefore available to act in combination with other idle "machines" to become "active" again. Consequently there are two basic searches to be carried out:

(i) Before an "event" takes place the "pool" of active machines must be inspected to find which machine is the next to become inactive and therefore fall back into the "idle pool." This defines progress in real time.

(ii) Immediately after an "event" the "idle pool" must be examined to see if any new operations can be initiated. Clearly certain priorities must apply and it may be better to wait a little while until more machines become idle so that a more important process can be initiated.

Dr. Tocher's team has built up a program which embodies these ideas, information relating to a "machine" being read into the computer in a special coded form. Statistical methods are employed wherever a variability is known to exist and the results of a simulation are essentially statistical rather than determinate.

Translation of Russian Articles

The Department of Scientific and Industrial Research Lending Library Unit has announced a scheme for preparing translations of Russian articles. The subject matter must be of recent scientific, technical, agricultural or medical interest, and one copy of each translation will be given free to the organisation requesting the translation.

Certain conditions must be observed, the chief of which are—

(*a*) no other translation of the article is available from any source;

(*b*) the original article is accessible to the Lending Library Unit;

(*c*) it is considered by the Unit to be of sufficient interest and is not too old;

(*d*) the organisation requesting the translation requires it for its own use, not for publication, and will edit it if required to do so.

BOOK REVIEW

High Speed Computing: Methods and Applications

By S. H. Hollingdale, 1959; 244 pages. (London: *English Universities Press Limited*, 25s. 0d.)

The first reactions of prospective purchasers of any goods today are frequently of the type "How much" and "How good value." This tendency is shown by the rapid growth of an independent Consumer's Association which aims to test goods and to report the results to members of the Association. The reviewer of a scientific book tries to apply tests and to convey the results to his readers; most of his tests depend not on clearly defined objective criteria but on subjective judgements. Frequently reviewers differ, charges of bias are made, and controversy is provoked. In the case of the book under review, part of its assessment of value seems beyond argument. The book is bound adequately and printed attractively and well on paper pleasant to handle; as such the price of 25 shillings is much less than might have been expected and compares most favourably with the prices of other books in the computer field.

The author states that his book is intended for the educated general reader; namely a reader with a broad interest in physical science, a school level of mathematics and no fear of a little mathematical symbolism. Such a reader will certainly be able to benefit easily from most of the book and with a little more effort from the remainder also. The author's style is an easy one and he has broken his text with many diagrams and photographs. The first four chapters ("Computing and Computing Machines," "Representation of Numbers in an Automatic Computer," "Introduction to Programming" and "The Pioneer Stage") cover the topics usually discussed in the first lecture or two of introductory and programming courses. There are a few places where a little more explanation would help the reader. Analogue and digital computers are said to be "each superior to the other in its own territory" (p. 6), but the territories are not defined here or later in the book; on p. 19 "excess-3" and "reflected" codes are introduced like the conjuror's rabbit and the mystery is only partially explained subsequently without a forward reference. In spite of this comment a useful feature of the book, and in particular of the early chapters, is the cross-referencing to the definitions of unfamiliar terms.

After this introduction there are chapters on EDSAC 1 and DEUCE; in each there is a description of the machine followed by a brief account of the method of programming. During its life EDSAC had additions and modifications to its order code and comments on how these changes affected the programme would have been interesting and instructive. There follows a chapter on "Storage Devices" which describes the types of store used in computers so far and one introducing the "Logical Design of Computing Circuits."

At this stage the author leaves design and detailed programming and considers the operation of a computing service and some applications of computers. An outline of the computer organisation at RAE is given, together with some of the operating records. The existence of simplified coding aids is mentioned but it is a pity that space has not been found somewhere for a more detailed account of one, together with some examples. So many new users of computers write their first programs in an Autocode that a description with the same amount of pruning as in the EDSAC and DEUCE chapters would have been valuable. One chapter surveys the applications of automatic computers (and, incidentally, includes an example in a matrix interpretive scheme), and the remaining chapters deal with three special applications. In the first of these the Monte Carlo method is introduced at what seems a parlour game level. Dr. Johnson is reported to have said about preaching by women that it was like dogs walking on their hind legs; it was not done well but it was surprising that it was done at all. The author, perhaps unintentionally, leaves his reader with a similar impression about Monte Carlo methods; some applications of Monte Carlo are certainly surprising, but in the hands of wizards at Harwell and elsewhere they are also extremely effective. Computer control of industrial processes and machine translation of languages are briefly described. There is a selected bibliography with over seventy references.

In any book containing illustrations of programming it is nearly impossible to avoid a few errors and misprints. The reviewer has not interpreted his duties widely enough to demand his checking of all the examples, but he did notice a slip on p. 37; and is not the infinitive of "rego," I rule, "regere" and not "regare" (p. 225)? Other obvious misprints are few.

Dr. Hollingdale's book gives a good introduction to automatic computers and their applications for the reader with a scientific background. Its price is so reasonable as to prompt inquiries why most other books on computing topics are so much more expensive. As such this book is a "good buy" and can be well recommended.

E. S. PAGE

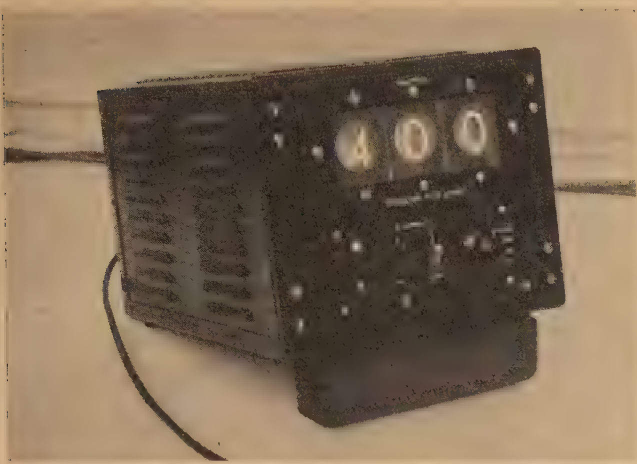
NRDC Aid Computer Development

National Research Development Corporation announce that they have decided to support two leading British manufacturers—*Ferranti Ltd.* and *EMI Electronics Ltd.*—in further development work on advanced high speed computers.

EMI have been collaborating with *NRDC* for the past four years in the development of a large business computing system—the EMIDEC 2400—the various units of which are already being manufactured and commissioned. The further program is aimed at the development of the EMIDEC 2400 computing unit to produce a system—the EMIDEC 3400—suitable for large-scale high speed scientific work.

Ferranti have been developing the techniques initiated at Manchester University by the group led by Professor F. C. Williams and Dr. T. Kilburn for the past ten years and in this work have been partly supported by *NRDC*. A new very high speed computer is now proposed—ATLAS—for application in scientific research and development establishments and for fast commercial and scientific data-processing.

NEWS FROM MANUFACTURERS



Solartron "999" Digital Voltmeter

Many physical quantities can now be converted electronically into an electrical voltage. To read-off these voltages to three-figure accuracy with certainty of the third figure often proves difficult with conventional meter dials and charts.

The new SOLARTRON 999 digital voltmeter type LM. 901 displays the measured voltage in large, plain figures, which may be read at considerable distance from the instrument and, if necessary, by untrained personnel.

The LM. 901 is lightweight and of compact and robust construction, and being transistorised it is rugged though small. It is self-contained, and its power consumption is extremely small.

The voltage range is from zero up to 99·9 V in three sub-ranges, or 109·9 V when using the range extension facility. The measured voltage is continuously monitored and the readings change with any variation. Alternatively, varying voltages may be periodically measured by turning a switch and pressing a "sampling" button when a new reading is required. The figures then remain at the last reading until the push-button is pressed again.

The digital display gives clear, white digits on a black or red background, according to the polarity of the voltage. This unambiguous presentation is achieved by a back projection system. The display may also be located remotely, or two displays may be operated from one digital voltmeter unit.

Simultaneously, the information displayed may be printed-out or otherwise recorded by a connection to the rear socket, which provides an output of full decimal coded information equivalent in value to that indicated by the display.

The Synchromatic Typewriter

Remington Rand have developed an electric typewriter operated by Hollerith 80 column cards. This could be useful for computer output since typing reproduction speeds are raised to 480 characters per minute and several typewriters can be linked to the one card reader unit. *Remington* have also developed the card-punching typewriter consisting of an electric typewriter linked to a Hollerith 80 column card punch. The cards are punched as a result of typing, the field selection and skipping being achieved by the normal Hollerith plugboard system. The Synchromatic Typewriter Units are the result of collaboration between *Remington Rand Ltd.* and *International Computers and Tabulators Ltd.*

Cheque Sorting Equipment

National Cash Register Company Ltd. have released for sale in the United States a magnetic character sorter-reader, jointly developed by themselves and *Pitney-Bowes Inc.*

The introduction of this equipment follows recommendations made by the American Bankers' Association for a common language in banking systems. The language adopted is based on characters in the arabic style which are printed with ink capable of being magnetised, read, and interpreted by electronic devices. With the customer's account number, bank code and, at a later stage, the amount encoded in magnetic ink, it is possible to process a cheque through the accounting procedures from the time of its receipt to its ultimate debit to the customer's account, without recourse to human handling.

The PITNEY-BOWES NATIONAL magnetic sorter, of which eight are already installed in the Bank of America, is one stage in this fully automated process. It is claimed that using conventional type cheques varying in length, breadth and thickness, it will sort items at a speed of 750 a minute. A combined vacuum and friction feed ensures separation and permits the intermixing of cheques of various sizes and thicknesses, which are accepted regardlessly by the Sorter and fed individually and successively.

It is capable of reading either on a digital basis for sorting or on a whole number basis. When reading whole numbers a printed list can be prepared showing the amount of each cheque passed and in addition a paper tape can be produced which will have punched into it such information as account number, cheque serial number, transaction code and amount.

E.M.I. Sales

J. Sainsbury Ltd. has placed an order with *EMI Electronics Ltd.* for an EMIDEC 1,100 computer. Its principal use will be for stock control and central accounting for supplies to branches. One of the main reasons for the choice of EMIDEC is stated to be its large immediate access store and rapid input and output facilities. No date is given for the installation of the computer or the start of the data processing system.

BEA have also ordered an 1100, costing over £250,000, for revenue accounting, costing and budgetary control.

An order has been placed by *de Haviland Propellers Ltd.*, Hatfield, for a large EMIAC II analogue computer as an additional aid to research into guided missiles and other problems associated with high-speed flight. The installation will consist of 22 modules and cost £52,000.

Units of another large EMIAC II, costing over £55,000, were recently delivered to the Whitley factory of *Sir W. G. Armstrong-Whitworth Aircraft Co. Ltd.* for missile work.

The Ferranti SIRIUS, a new transistorised desk-size electronic digital computer, designed to fill the gap in the small general purpose computer field.

Sirius—New Ferranti Computer

SIRIUS, a new addition to the *Ferranti* range of digital computers was on show and working at the International Convention on Transistors and Associated Semiconductor Devices in May. This is a small, general purpose, fully transistorised digital computer designed for a wide variety of statistical analysis, technical calculations and process control applications.

SIRIUS is to be sold for £15,000 and will go into production in September 1959 with delivery quoted as three months. The machine at the Convention has been installed at *Ferranti's London Computer Centre* and is hired out for technical, scientific and statistical applications at the low rate of £15 per hour.

The input and output to SIRIUS is by means of punched paper tape and the printing is by teleprinter. It contains a store of 1,000 words on 20 nickel delay lines, 50 words to a line, and in addition it has eight single word accumulators any of which can be used as modifiers. The basic pulse of $\frac{1}{2}$ megacycle and the addition time of 240 microsec. are faster than PEGASUS ($\frac{1}{3}$ megacycle), but because of the waiting time of up to 4 millisec to obtain data and instructions from the long delay lines, the operational speeds are slower than PEGASUS. *Ferranti* feel, however, that the much lower price of SIRIUS will make it competitive on some of the larger jobs (especially input/output limited applications) and cause smaller jobs to be economical on a computer for the first time.

The machine operates in binary-coded decimal with four bits to a decimal digit and ten decimal digits to a word. Alphabetic characters can be accommodated by using two decimal digit positions. *Ferranti* state that they can make available additional storage in cabinets of 2,000 words on nickel delay lines and this is catered for in the address part of the order code.

SIRIUS weighs only 5 cwt. and measures approximately 7 ft by 3 ft 6 in. by 4 ft high, including a standard RONEO desk, and it can be powered by plugging into ordinary power sockets in any office or laboratory. There is no need for expensive installation construction or for air-conditioning.

This is *Ferranti's* first use of transistors in computers, and they wish to gain field experience of them. But the biggest development in SIRIUS is the new package logic in which transistors are only one of the elements. The new packages, called NEURON plates, are the result of several years' development and are very different from the package logic of PEGASUS. For instance, no pulse amplification is required in a circuit because each plate sends out a fresh signal, and this simplifies the calculation of the necessary circuits. In SIRIUS there are 600 plates of ten types, but 85% of the plates are of one type, and one type can perform several different operations depending on how it is wired. *Ferranti* claim that with these NEURON plates they can design and assemble large data processing systems without an overwhelming cost burden; and it is to be expected that this will be their next step.

REPORT ON
THE BRITISH COMPUTER SOCIETY FIRST CONFERENCE

CAMBRIDGE

22—25 JUNE 1959

By Dudley Hooper

Some of the visitors from overseas with the President and Chairman: (l. to r.) Dr. E. Goto (Japan), G. Nielen (Holland), E. C. Berkeley (U.S.A.), Dr. Wilkes, Dr. Yates, Dr. R. H. Gregory (U.S.A.), Professor A. Perlis (U.S.A.), Dr. C. V. L. Smith (U.S.A.), Dr. A. S. Householder (U.S.A.)—photo Mill Road Studio, Cambridge

[This report has been compiled from the author's own notes and the summaries he prepared for the press, from additional notes made by Dr. A. S. Douglas, Mr. H. W. Gearing and Dr. S. Gill (particularly on parallel sessions which the author was unable to attend), and in some cases from synopses provided by the authors of the papers.

Short notes only are given of those papers which it is expected will be published in The Computer Journal.

Except where otherwise stated, the photographic illustrations are by the author.]

The first conference of the British Computer Society was held in Cambridge from 22 to 25 June 1959. The main sessions were held in the Arts School with closed circuit television for an overflow room. With the parallel sessions using the Lecture Theatre in the Mathematical Laboratory, 325 delegates stretched capacity to the limit. Timed to take place a week after the International Conference on Information Processing held in Paris by UNESCO, the Society's Conference attracted 57 overseas delegates, many of them pre-eminent in their spheres. That the Society was able to take on such an international flavour at its first Conference is an undoubted mark of its standing in international affairs.

Eleven countries were represented besides Great Britain, as follows:

United States	25
Holland	12
Israel	4
Japan	4
Sweden	3
Switzerland	3
Belgium	2
Canada	1
Czechoslovakia	1
Germany	1
Italy	1

The delegates, 212 members and 113 non-members and guests, covered a wide range of interests, shown by the following table:—

General Industry	83
Manufacturers of Computers and Ancillaries	53
Government Departments and Establishments	48
Universities and Technical Colleges and Institutes	44
Research Institutes and Establishments	23
Professional Accountants and Consultants	13
Nationalised Industries	12
Banking, Insurance and Local Government	4
Technical Editors	2
Unclassified	43

Much of the value of the Conference came from the opportunity for discussion. No formal papers were circulated in advance, and much of the time of the delegates was occupied by symposia, at each of which three or four speakers contributed their experience; this usually resulted in lively discussion and for one symposium an extension of the time allocated to it had to be arranged.

By invitation of the President of the Society, as Director of the Cambridge University Mathematical Laboratory, arrangements were made for parties to visit the laboratory and particularly EDSAC 2. So popular was this that Dr. Wilkes found it necessary to arrange a special introductory lecture to save the time of the laboratory staff in conducting the visitors. Primarily for the benefit of overseas visitors, visits round places of interest in Cambridge were arranged; the Society is indebted to undergraduates in residence for acting as guides.

More than half the delegates attended a Conference dinner in Kings College Hall on the last night of the Conference.

The conference was organised by a Committee under the chairmanship of the President, with Messrs. E. C. Clear Hill and L. R. Crawley, Dr. A. S. Douglas, Messrs. H. W. Gearing, D. H. Rees and R. H. Tizard, and Mr. E. N. Mutch as Hon. Secretary to the Conference. Members of the staff of the Cambridge University Mathematical Laboratory provided secretarial service for the Conference and also provided facilities for the Press Committee.

* * *

SESSION 1—PRESIDENT'S ADDRESS

The opening address and a report on the International Conference on Information Processing held in Paris by UNESCO on 15–20 June 1959 was given by the President of the Society, Dr. M. V. Wilkes. Dr. F. Yates (*Chairman of Council*) was in the chair.

Welcoming delegates to the Conference, the President said—

"It is almost ten years to the day since the last Computing Conference (the first in Europe) was held in Cambridge, which some 140 delegates then attended.

"I am glad to say that the decision to hold this Conference has been very warmly received and the delegates present include many members and others from overseas—the importance and distinction of whom can be seen at a glance by only the most casual reference to the list of delegates which has been circulated to you.

"Although it is almost ten years since the original Conference was held at Cambridge, it is not yet two years since the British Computer Society came into being.

"Many of those who have worked towards its formation have been most encouraged by the way in which the business and scientific interests in this subject have come to work side by side around a Council table; in so doing, contributing to the fuller utilisation of our industrial and intellectual resources, so enabling us to compete the more effectively

Before the opening session: the President, Dr. M. V. Wilkes (centre) with Dr. F. Yates, Chairman of Council (right) and D. W. Hooper (left), immediate past chairman —photo Mill Road Studio, Cambridge

with the progress now being made in these fields in other parts of the world.

"Our Society has already a membership approaching 2,000. This, surely, is indicative of the vigour with which the people of this country are identifying themselves with the possibilities now afforded by the more advanced of Britain's computers. We look forward, in the near future, to a better realisation of the benefits which computers can bring to business managements.

"Much of the success of this Conference will, I believe, stem from the discussions ensuing from the papers which should lead to further studies not only within the precincts of Universities but in the Boardrooms of our commercial and industrial organisations."

(*The President's paper on the UNESCO Conference is reproduced on page 53 of this issue of* The Computer Bulletin.)

* * *

SESSION 2—THE STATE OF THE ART

The opening Session on the first full day's work of the Conference was a review of computer activity in the United Kingdom at the present time. Mr. J. A. Goldsmith spoke on "Commercial Computers in Britain," and Dr. A. S. Douglas (*Director, Electronic Computing Laboratory, University of Leeds*) spoke on "Computers in British Universities." Mr. D. W. Hooper (*Member of Council*) was in the chair.

Commercial Computers in Britain

The present time in the field of commercial applications of computers, Mr. Goldsmith said, was one of consolidation and getting down to the job of making them work efficiently, rather than one of outstanding progress. Mr. Goldsmith thought that the days of "the expert" talking of his non-existent computer experience were past. Users were now beginning to get some useful experience, but in the main had not developed their systems sufficiently fully to claim outstanding successes, at any rate publicly.

Up to the beginning of June, 109 installations of "commercial" computers had been ordered or delivered. Of these, 67 were punched card machines and 42 magnetic tape machines. Of the 67 punched card machines, 49 had been delivered, compared with 30 twelve months ago and 7 the year before that; of the 42 magnetic tape machines, 27 had

A. S. Douglas and J. A. Goldsmith after their session on the state of the art

been delivered so far, compared with 12 twelve months previously and three a year before that.

There had been few new orders for machines during the last few months and it seemed that the flow of new orders had temporarily stopped while potential users were waiting to see what success was achieved on the present installations or, in some cases, were waiting for new models. The work done so far on the larger machines had in general been unambitious and the achievements had been disappointing compared with the amount of effort put into their installation. Their full facilities were not being used and some were doing jobs which could have been done equally well on smaller machines.

Commercial Applications

Most users had found that the cost of preparing media, and the cost of installing a computer on a routine accounting operation, had proved to be more than that originally forecase some years ago. On the other hand, it had been found that the routine, once programmed, flowed automatically and required less clerical effort; the installation then takes over many associated jobs and deals fairly easily with special circumstances which may arise.

Of the 109 "commercial" installations ordered or delivered (referred to previously), 52 were primarily concerned with payroll. It had been shown that a large payroll could be an economic job. Stock control was the prime purpose of 34 of the installations; new statistical techniques for controlling stocks of finished goods and making sales forecasts were being developed. 17 installations were primarily for invoicing; the efficiency of these systems varied widely. Where there was a complicated discount system there were advantages in operating this sort of procedure on a computer, but it was doubtful if a simple invoicing job with simple pricing was economic.

It was disappointing that only 14 installations were concerned with production control. This appeared to be the field in which computers could be most effective, with their ability to process data very rapidly for management. Two installations were concerned with operational research, and some useful work had been done with linear programming.

There was still a large gap between top management and the people running the computers. Mr. Goldsmith felt that it would be five to ten years before computers played a full part in helping management to control their organisations effectively. Computers in this field tended to be looked on only as advanced accounting machines.

Computers in British Universities

Dr. Douglas emphasised that he was dealing only with electronic general purpose digital computers in British universities and that his remarks represented his own personal views. Until about two years ago, he said, only London (Birkbeck College), and Manchester and Cambridge Universities had working computers.

At Birkbeck, Dr. A. D. Booth had constructed the APEX(C), a small drum machine, and this project was associated with the Physics Department.

At Manchester, there was first the Mark I medium speed two-level computer, with a large drum; this was a fixed point machine. There was now the MERCURY fast two-level computer, with several drums; this was a floating point machine. These projects had been associated with the Electrical Engineering Department.

At Cambridge there had first been the EDSAC 1 medium speed, small, single level (isochronistic) computer, a fixed-point machine, followed recently by EDSAC 2, a fast, fixed or floating-point machine with ferrite store and magnetic tapes. These projects had been associated with the Mathematics Department, under Dr. Wilkes.

Scope of Work

Up to the present these machines had been mostly engaged on research and there had been little or no undergraduate teaching. There had been some post-graduate teaching in numerical analysis (particularly at Cambridge), electrical engineering (particularly in Manchester) and in programming. The machines were generally operated on the "open shop" system, under which specialist programmers were developed in outside departments to run problems for themselves. Extra-mural work had been accepted at Manchester, but not at Cambridge until very recently. The early machines were treated as engineering experiments, with service work taking a subsidiary role.

Later University Machines

Over the last two years PEGASUS machines had been installed at Durham, Leeds and Southampton; DEUCE machines at Glasgow and Liverpool; MERCURY machines at London and Oxford. Magnetic tape had been added to the PEGASUS at Leeds University in February of this year.

The primary use of these machines was to be for training undergraduates in numerical analysis, post-graduate diploma courses, and extra-mural training for other computer users. There would also be internal service work and some external service work.

The precise way in which each machine would fit in with the training programmes of the University concerned depended to some extent on the place that the laboratory concerned held in the University organisation, and the pattern was diverse.

The research work undertaken on University computers covered a wide field, but service work for bodies outside the University was not considerable; it was mainly to run up programs for installations in the vicinity.

Dr. Douglas added a few notes on housing and on reliability. He illustrated with slides an amusing comparison between the palatial laboratory premises overseas and the more usual appearance of mathematical laboratories in this country, depicted by the disused chapel in which the Leeds computer is housed.

H. W. Gearing, John W. Carr III, A. S. Douglas (session chairman), R. W. Bemer and B. Richards before the symposium on programmer training

SESSION 3—THE SELECTION AND TRAINING OF PROGRAMMERS

This session was the first symposium of the Conference. There were two speakers from the United States and two from this country, followed by a short open discussion. Most speakers indicated that the increasing use of automatic coding procedures would reduce the need for highly skilled programmers, who would in the main be required in future only for writing the "master programs" in the chosen common language of the machines.

From the United States, the principal speakers were R. W. Bemer (*Manager, Programming Systems, IBM Data Processing Division, White Plains, New York*) and John W. Carr III (*Director of Research, Computation Center, University of North Carolina*). From this country, principal speakers were H. W. Gearing (*Head of Computer Division, The Metal Box Company Ltd., London*) and B. Richards (*Central Instrument Laboratory, Imperial Chemical Industries Ltd., Reading*). The Chairman was Dr. A. S. Douglas (*Member of Council*).

United States Practice

United States practice in the selection and training of programmers was given by Mr. Bemer. He suggested that the different approach previously apparent between that of the machine builder and the machine user was disappearing, as was also the distinction between the requirements of some scientific and business users.

His company selected their personnel in four ways—

(*a*) From other professional fields.

(*b*) By selecting from their own organisation employees who were capable of recognising that computer programming needs reorientation of some thought processes.

(*c*) By engaging the few programmers already trained in the field, who could be obtained from other firms; they were scarce, but they tended to move around from one firm to another to gain experience.

(*d*) By appointing college-trained personnel who were just starting in the field; they were mostly interested in scientific applications and few could be found to specialise in business processes.

Selection primarily was by using aptitude tests, which derived from the work originally carried out in this field by *The Rand Corporation*. They consisted of a basic IQ test with added special appreciation tests. In the speaker's experience, however, the most essential factor was that the prospective programmer should have horse-sense. No particular background seemed to make the best programmers, although he found that they were usually chess players or puzzle solvers. It was essential that they should have the ability to work as a member of a team and not alone. He would prefer them to have some previous experience on almost any type of computer, and it was essential that they should have had a good general education.

Training Sources

There were many ways by which programmers could learn their craft and a combination of a number of the following means was required—

(*a*) Courses by manufacturers—IBM trained 1,800 of their own programmers and over 10,000 for their customers, annually; this was in addition to parallel training on punched card equipment, management, etc., amounting to over 10,000 per year.

(*b*) Collegiate training—there were 18 Universities in the States with large computers and 83 with medium-sized machines; several high schools were also starting to train programmers and he suggested that the earlier training started, the better.

(*c*) Re-training by manufacturers on new machines.

(*d*) Professional meetings of societies, who served a valuable purpose in disseminating information.

(*e*) Books, scientific journals and periodicals.

(*f*) Consultant services.

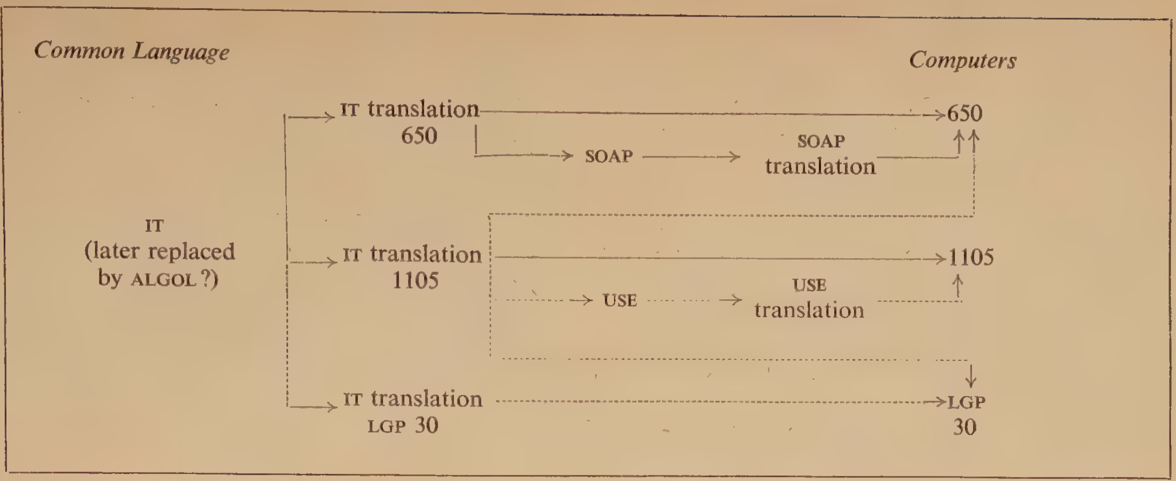
It was essential, Mr. Bemer said, to move trainees and programmers about for experience. There was a trend towards eliminating the shortage of programmers by designing machines to program (by FORTRAN, for example). The user therefore would need only simple knowledge within the competence of his own engineers and production people. Only the manufacturers of computers would need highly technical programmers to initiate the machine programs.

* * *

Avoiding Training Programmers

After stating that he was strongly opposed to aptitude tests (possibly because he once flunked both those of *Remington Rand* and *IBM*), Dr. Carr suggested that IBM developed logicians for computing machines, rather than programmers, whereas he, as a University user, was more concerned with how to avoid training them. He saw the purpose of a University in this field as the continuing production of humans to use computers to solve problems in thought and to produce continuing research on how to use the computer.

He had a particular problem in that N. Carolina University was centred in three separate locations up to 50 miles apart, with three machines, each of a different type. As a long-term project it might be possible to link the three locations with micro-wave circuits feeding one central large-scale computer. To use the present machines, however, they were developing an algebraic language (IT) in which problems



could be set in common language and translated into the language of each machine. These thus became special purpose machines, one primarily being used for scientific applications, one for social sciences and one for commercial processes. Later the first experimental language, IT, might be replaced by the ALGOL language now being developed on a wider scale in America and other countries. By making use also of SOAP and USE automatic programming codes he envisaged a set-up over the three machines something on the lines of the above chart. The dotted lines indicate possible future developments.

A similar set-up could be used by any large organisation with a large number of out-stations, each with its own small machine, of varying type, and one central large machine.

* * *

U.K. Training for Commercial Programming

Mr. Gearing, speaking as a potential commercial user, said that his organisation already had training experience, for example in the field of automatic production devices and on the more complicated types of office machines. There was therefore a nucleus of experience in using training techniques.

Initially they recruited a team of six potential programmers, three of their own staff and three from outside sources. At first it was considered that a University degree was necessary, but early experience showed that a fairly wide knowledge of the applications being studied was necessary. These applications initially were directed to the extension of business systems not yet mechanised in any way and to those systems which could be done more thoroughly than at present. Their normal method of training was to send programmers to manufacturers for basic courses and then for them to write programs for models of the real job on which they would ultimately be engaged. His impression of manufacturers' courses was that some have concentrated on scientific and mathematical work, while others with more interest in business applications have gone to the opposite extreme and stressed that office applications are only an extension of existing punched card and similar routines.

Some Points on Selection and Training

Eight points were suggested by Mr. Gearing as being worth consideration—

(*a*) The mixture on their programming staff of knowledge of the business with a fresh academic approach had been found to work well.
(*b*) All programmers should have a detailed knowledge of the machine and of its ancilliary equipment; systems men associated with data processing must take programming courses.
(*c*) It is better to select plodders who will attend to detail rather than bright mathematicians who may be too inclined to search for short cuts and other perfections.
(*d*) Programmers must have facilities to exchange experience (especially between scientific and business applications).
(*e*) It is helpful to study systems and machines other than those used in one's own organisation.
(*f*) Jobs to be programmed should be allocated so as to make the most use of each individual's past experience and thus get the best out of the team.
(*g*) Rigid rules should be drawn up for filing working papers on all programming jobs. Every programmer has his own tricks, and after a program has been tested it must be documented in a form which will enable any trained programmer to follow through the operations.
(*h*) Programmers should be given time to write flexible and well written programs, as this only has to be done once and requires less revision and amendment; time spent testing a model is well spent.

Mr. Gearing emphasised the importance of recruiting and training a nucleus of programming staff some time before the machine is selected. This gives a better internal appreciation of the job and of the facilities available on different machines to carry it out.

* * *

Direct Contact with User

In the development stage of an installation, Mr. Richards saw the need for two types of specialist, in addition to the technical people directly associated with the operation of the computer: those who would develop work which is known to exist, and those who would develop new work.

While there would always be some need for those experts developing new work on the computer and writing new programs, he would hope that the most important people would be those who carried out liaison and acted as

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interpreters between the machine and the chemists, engineers, or physicists using the machine.

In time, these latter users should be making direct contact with those operating the machine, with the aid of some automatic coding.

Training User in Appreciation

He did not feel that one should select programmers by aptitude or psychological tests; it was far more important to train the user in appreciation. He felt that, in this country, courses generally had too much emphasis on machine coding and not enough on proper appreciation of systems, and such related matters as flow diagrams, or on the mathematical techniques of solving problems. Within any one organisation there was much to be said for the use of a standard machine.

* * *

Experience with LEO

In the open discussion which followed the four main speakers, Dr. J. M. M. Pinkerton (*Leo Computers Ltd.*) endorsed Mr. Gearing's emphasis on the need to obtain programmers in advance of the machine being delivered, and suggested one year as a minimum. His own company's staff of programmers had been selected by a one-day appreciation course, followed by simple tests to see how much of the course they had absorbed. This was a direct and straightforward test of ability to absorb simple theories. Training consisted of a five-weeks' intensive course, which was also available to customers' programmers, followed by six to nine months' working experience under more experienced programmers.

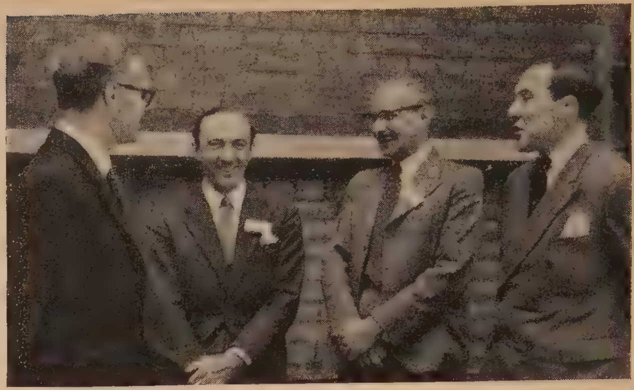
Need for Mathematical Techniques

Mrs. M. M. Barritt (*R.A.E., Farnborough*) described the success they had had in teaching programming to 17-year-olds and also teaching the appropriate mathematical techniques to go with programming. They had five machines operating on an "open shop" basis. Dr. J. Howlett (*U.K.A., E.A., A.E.R.A., Harwell*) supported previous speakers' emphasis on the need for more appreciation of mathematical techniques for solving problems, but warned against selecting those who are good mathematicians for mathematics' sake. The use of automatic programming such as auto-code would reduce the need for a large staff of programmers, but one would always need one real expert to program behind the automatic programming system. The best training of all, he suggested, was to work on the job itself and to exchange experience with others.

* * *

SESSION 4*A*—SOME PROBLEMS OF AUDITING COMPUTING DATA—Internal Audit Practice and External Audit Theory

This symposium, primarily of interest to business users of computers, nevertheless attracted a large audience and provoked an animated discussion, not confined only to the views of professional accountants. Principal speakers were Mr. A. J. Bray (*Turquand, Youngs & Co.*), Mr. T. R. Thompson (*Leo Computers Ltd.*) and Mr. F. C. de Paula;



After the symposium on auditing problems: T. R. Thompson, F. C. de Paula, L. R. Crawley (session chairman) and A. J. Bray

Chairman of the symposium was Mr. L. R. Crawley (*Standard Telephones and Cables Ltd.*), (*Member of Council*). These speakers, and those who followed in the discussion, made it clear that they were expressing their personal views and not those of the professional bodies of which they were members, or of the firms to which they were attached.

External Audit Consideration

Introducing the subject, Mr. Bray emphasised the deliberate choice of words in the title "Internal Audit *Practice* and External Audit *Theory*." The use of computers for accounting procedures was in its early days and there was as yet no fully integrated system of electronic data processing operating. The approach of external auditors could, therefore, only be theoretical at the moment in their consideration of the circumstances with which they might be faced.

He drew attention to the auditing requirements of the Companies Act, 1948, emphasising the duties of the auditor, particularly in relation to his duty to report as to whether proper books of account had been kept. Would it be possible for the auditor to accept magnetic tape records, for example, as proper records? He pointed out that recent changes in the Act, and legal decisions, had established that loose-leaf records could be accepted in certain circumstances in place of bound books and registers. The Act (Section 436) permitted registers and books of account to be kept "either by making entries in bound books or by recording the matters in question in any other manner." Are magnetic tapes, films, drums and discs within the meaning of this section of the Act?

He suggested that the problems arising from auditing computer data, as they affected the external auditor, might be summarised as—

(*a*) following through an accounting procedure where a record of the interim stages had not been made, and
(*b*) relying on electronic and magnetic storage which cannot be read visually and in its natural form.

* * *

Importance of Adequate Procedure

Mr. Thompson referred to the early experience of Lyons, *vis-à-vis* their own auditors. He thought the auditors would be the first to admit that in 1947 they did not understand much about the computer. He suggested that one of the objects of internal audit in relation to a computer system was to ensure that the records adequately reflected the transactions of the firm at any one time.

There were three approaches to internal audit in this context. Firstly, it was possible to check that the results (the payslip, for example) were correct according to the original data; secondly, one could work from the original data and see that it produced the right results; thirdly, one could check the procedure between the initial data and the end results.

If the procedure was adequate, it was probably more organised than it had been before and therefore easier to grasp overall; further, many program checks would probably have been written into the procedure because the programmers, particularly in the early days, were mostly mathematically trained and were therefore used to writing mathematical checks into mathematical routines.

Falsification of Procedure

Much had been written about the possibility of falsifying the procedures within the computer. This was possible in theory, but he felt that it would be very difficult in practice to organise. A much easier fraud would be to falsify the original data. This might be vulnerable, as under a computer system not so many people handle data during preparation. Consistency checks within the machine programs help to detect wrong data.

In general, the error percentage was much lower than in ordinary systems. In fact, many users had found that the first parallel runs usually showed errors in the old system rather than in the new. As the system developed it was essential that the auditor kept pace with the revision of programs.

* * *

Program Changes and Amendments

The importance of vouching the original transactions was stressed by Mr. de Paula; from the very automatic nature of the system, there was a greater probability that identical procedures had been followed for every transaction so that a smaller test would prove a larger volume of data. The auditor would have to be careful, however, that his past reliance on the association of many humans with any particular procedure would no longer be so valid with fewer people, and the protection provided by humans would diminish.

He stressed the need for being satisfied that there was a proper internal discipline on such matters as change of program; the auditor has no direct check that the right program has in fact been used for the whole run and he might require a log to be kept of the programs used. He would certainly need to be more concerned with internal check and system procedures and it might be that he should retain copies of the fully documented system and flow charts. Further, with the computer there must be a change in timing of the audit; several months after the event would be too late for an effective audit.

The auditor would have to be interested in the procedure used for correcting errors. Where minor errors could be corrected by manipulation of switches on the console, it might be that all corrections should be printed out by program. This was one aspect of fraud, and Mr. de Paula suggested that there should be sufficient hardware in the machine so that there could be a print-out of all knob setting and movement of switches; the same device could also be used for maintaining a locked machine print-out giving a log of all programs used.

He could foresee the time when sample data might be tested on another machine. Since the auditor would require the brought-forward balances, this raised the question as to how long these should be retained (such as on reels of magnetic tape).

* * *

Discussion Points

The suggestion that the auditor might be required to keep up-to-date documentation and flow charts of the system was questioned by Mr. O. S. Lumb (*General Electric Co. Ltd.*) who wondered whether the auditor would be able to cope with the continuous amendment necessary on most programs. Mr. R. W. Bemer (*I.B.M. Corporation, U.S.A.*) drew attention to the current development of a program language in understandable and standard English, which would help auditors and programmers to talk the same language. On the question of fraud, Mr. E. J. McCluskey (*Bell Telephone Laboratories, U.S.A.*) suggested that, on a computer programmed by punched cards, it would be possible to insert an additional loop or pack of cards in program or data, which could be removed after the program run; Mr. H. W. Gearing (*Metal Box Co. Ltd.*) questioned how many frauds, in fact, had been carried out on punched-card systems. Mr. D. W. Hooper (*National Coal Board*) remarked that the speakers so far had not referred to the importance of auditing the control accounts: he suggested that these would normally be more complete and comprehensive with a computer installation, and could be audited as normal accounts. He agreed with Mr. de Paula's point of the importance of early audit; he suggested that auditors could no longer expect to wait until the books were written up before starting the audit. It might come to the time when the auditor was actually living on the job; this might even be cheaper than Mr. de Paula's additional hardware.

Dr. M. V. Wilkes (*the President*) also referred to this additional hardware. Any device of this nature, such as a special printer in a sealed box, raised all the objections associated with hardware, such as the need for maintenance and testing. In any case, it would be necessary for the maintenance engineer to have a key to the box.

Internal Auditors Trained as Programmers

Mr. H. A. Y. Dyer (*Ministry of Supply*) suggested that some of the internal audit staff must be fully trained programmers. They should have their own test packs for programs and for machine accuracy, covering a much wider field in their audit than hitherto. Mr. Grover (*Courtaulds Ltd.*) feared that the maintenance engineer and the auditor between them would be taking more time on the machine than was available for operating. He suggested that the auditor should be charged

for time on the machine as a means of showing the amount of use.

Mr. C. A. Wilkes (*I.C.I. Ltd.*) had now had 18 months' experience with magnetic tape and was at a loss to understand why the external auditors should be so excited about computers when they were not so excited some years ago when punched cards were first introduced; one would have thought that in those days they would have had just as much difficulty in reading a punched card. His philosophy towards external auditors was that, if they really wanted to check all the balances on magnetic tape, he would give them all the original invoices and let them add them up. He also found it difficult to see why people were so worried about switch movement and button pushing. In his installation buttons on the console were used only to start or stop the machine.

Mr. J. T. H. MacNair (*Thompson MacLintock & Co.*) gave an example of a simple fraud on a machine system, by which a balance was not listed but, with the machine set to non-print, was included in the total so that the control account was not out of balance. He suggested that if this fairly substantial fraud could be carried out on orthodox machines, it could equally well be carried out on a computer. He wondered why the red herring of the Companies Act had been dragged into the discussion; if it had been possible the carry out an audit, then there must have been sufficient books of account or records. He suggested that the external auditor was not concerned with minor frauds, but could rely on simple additional checks on interruption to the agreed procedure to show to what extent it had in fact been carried out.

The use of the computer as a tool by the auditor was suggested by Mr. C. P. Marks (*Ministry of Supply*). It opened up the possibility of using sampling techniques on probabilities of error, and the auditor might need to revise many of his procedures and to re-think his own problems.

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SESSION 4*B*—THE LOGICAL DESIGN OF COMPUTERS

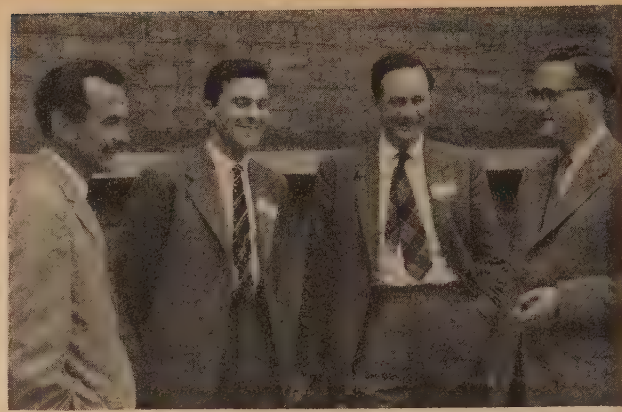
As a parallel session to the symposium on auditing, a symposium on the logical design of computers attracted great interest and it was necessary to continue it in a subsequent period to give more time for discussion.

Principal speakers were Dr. T. Kilburn (*Reader in Electronics, Manchester University*), Dr. M. Lehman (*Scientific Department, Israeli Ministry of Defence*) and Dr. N. C. Metropolis (*Director, Institute for Computer Research, University of Chicago*). Dr. S. Gill (*Ferranti Ltd.*) was in the chair.

New Manchester Computer

A description of the new MUSE computer, now under development at Manchester University, was given by Dr. Kilburn. This will be a very high speed machine, completing the addition of two numbers, for example, in one ten-millionth of a second; this high speed is achieved by a transistor circuit invented by Dr. Kilburn, which transmits the carry over from one digit position to the next at a quarter of the speed of light.

The mean rate of obeying instructions from the core store will be about 700,000 per second. An important feature of



Before the symposium on logical design: N. C. Metropolis, M. Lehman, S. Gill (session chairman), and T. Kilburn

the machine will be a fixed store of 8,000 words, with an access time of 0·13 microsecond; this store will hold many routines concerned with programmed arithmetic and with the organisation of transfers to and from magnetic tape and other input and output media.

An Inexpensive Machine

Dr. Lehman described an analysis he had made of the cost of commercially available computers, and came to the conclusion that materials accounted for only about 10% of the price.

He and his colleagues therefore set about planning a machine using only $12,000-worth of equipment, simply constructed. This machine is intended for general scientific computing work in his organisation on an "open shop" principle, and will have an 8,000-word drum and a 128-word core store.

A New Large Machine

A new machine being built in the Institute for Computer Research at the University of Chicago was described by Dr. Metropolis. This machine is modelled on MANIAC II at the Los Alamos Scientific Laboratory. It will have 8,000 or 16,000 words of core store with a cycle time of only two microseconds, and 4 magnetic tape decks.

He also described an interesting form of floating point representation of numbers that will be used in the computer. This will avoid the appearance of large numbers of meaningless digits at the end of approximate numbers, whilst retaining a few guarding digits against rounding errors.

* * *

In the subsequent discussion, Dr. A. R. Edmonds (*London University*) suggested that perhaps 80% of the programs of the future would probably use some kind of autocode and asked whether the order code of MUSE had been planned with this in mind. Dr. Kilburn confirmed that this was certainly envisaged, as it had been with MERCURY. The subroutines in the fixed store of MUSE, and the large number (128) of index registers, were intended to assist in the use of an autocode.

S. Gill giving his review of automatic programming at a full session in the Arts School

SESSION 5—AUTOMATIC PROGRAMMING

The second day of the Conference opened with a review of current theory and practice in automatic programming by Dr. S. Gill (*Ferranti Ltd.*, *London*); Dr. J. Howlett (*U.K.A.E.A.*, *A.E.R.E.*) was in the chair.

Computer programming has now developed from a science into an art. Individual techniques no longer matter; of more importance is the well-chosen combination of the facilities embodied in a programming language. The present situation of these is difficult to summarise as it is still one of active development.

Because of varying requirements, of experts and novices, in different situations, a variety of different languages is being devised, each capable of being accepted by a computer with the help of processing routines. Dr. Gill emphasised the importance of the provision of well-written manuals describing a language. A rapidly growing interest is being shown by manufacturers in the development and presentation of such languages.

Processing routines also are now being developed; these assist the person responsible for actually operating the computer, by keeping a log of work done, informing the operator when, for example, a reel of magnetic tape is to be changed, and making it possible to restart a calculation at a suitable point after a breakdown.

Common Languages

There is a trend towards the use of alphabetical coding; this started in scientific work but is now becoming of great interest to business users. It is now also often possible to define words for use in a particular program; this is a possible salvation for business users who have difficulty in reaching agreement on the meaning of words.

Currently there are attempts to standardise a language for international use. Here there are two points of view: firstly, the feeling that if a common language is not determined and accepted now, some existing language will drift into common use although it may not be fully acceptable to all users or as good as it might be; secondly, the opinion that the time is not yet right to establish more than a few essential features of languages.

The British Computer Society has two committees working on common languages, one for scientific and the other for business needs. The committee working on the scientific requirements of a standard language has endorsed the second viewpoint, that it is too early to attempt to formulate a comprehensive common language, but that a number of essential features of such languages could be established. Workers in other countries of Europe and in the U.S.A. are, however, preparing to use a common language called ALGOL for scientific programs. The position is further confused by many other things, such as the variations in the range of symbols available on typewriters, key punches, and printers.

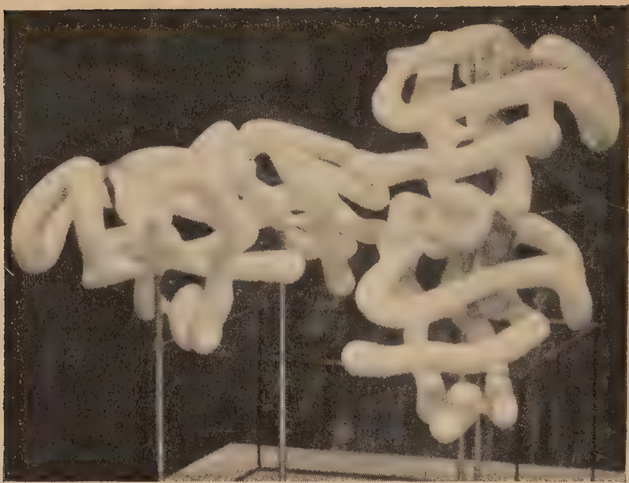
During the discussion which followed, Mr. J. H. Wensley (*Computer Developments Ltd.*) revealed that International Computers and Tabulators Ltd. had invited other manufacturers of computers to meet together to discuss the formulation of a common language for use in programs for business applications; all the invitations have been accepted.

* * *

SESSION 6—A SCIENTIFIC APPLICATION IN CRYSTALLOGRAPHY

A fascinating account of a large computer application of general interest was given by Dr. J. C. Kendrew (*Medical Research Council Unit*, *Cavendish Laboratory*, *Cambridge*); this dealt with the calculation of the crystal structure of the protein myoglobin. The paper was a model for those faced with the necessity of making a technical matter understandable to laymen; Dr. Kendrew stimulated delegates by his clear and interesting exposition, illustrated by models and slides. Dr. M. V. Wilkes (*President of the Society*) was in the chair.

This application had its small-scale beginnings on EDSAC 1 nine years ago and has now grown into a major data processing scheme on EDSAC 2. The protein myoglobin is a chemical substance which occurs in animal muscle and is the substance that makes meat red. Its function is to absorb



"... *like something by Henry Moore* ..."

and store oxygen in the blood and the particular samples studied came from whale meat.

The behaviour of all living organisms depends chemically upon the structure of enzymes which are all proteins. These proteins contain chains of amino-acids, compounds of carbon, hydrogen and nitrogen, together with other elements such as iron, which accounts for the oxygen-absorbing-properties of myoglobin. It is somewhat simpler than the better known protein haemoglobin but, like all proteins, its molecules are very complex and contain many thousands of atoms. In order to understand the chemical behaviour of proteins, and their function in living organisms, it is necessary to discover not only their chemical structure (that is, the order in which the atoms are linked together to form chains), but also the way in which the atoms are arranged in space (that is, their molecular architecture). Standard methods of X-ray crystallography can be used to provide the data since many proteins form crystals similar to those of simpler substances; but proteins are much more complicated than the molecules whose structures have been determined by crystallographers in the past.

Structures in Three Dimensions

The study of the structure has been carried out by using the technique of irradiating a crystal of myoglobin with X-rays. Irradiation results in a characteristic pattern of X-rays reaching a suitably placed film or geiger-counter by which this pattern is recorded. Since a crystal is a repeating structure in three dimensions, it is possible to treat these diffraction patterns mathematically by a method analogous to the way in which the notes of a violin can be analysed into a basic tone associated with a set of harmonics. The records received on the film lack one vital piece of information, however, the phase of the wave reaching it, but the amplitude of the wave can be measured. To find the structure of the unit cell of the repeating pattern it is necessary to guess the phases and carry out extensive calculations to obtain the structure appropriate to those phases. Assuming this structure to be reasonable, the phases are guessed again and the calculations repeated, giving successively better approximation to the actual structure. The volume of data to be handled is very large and the computing procedures are complicated. Had it been necessary to carry out these procedures by hand methods the sheer volume of work involved would have made it impossible to make much progress; the use of high-speed computers has been absolutely essential.

To complete this sort of computation may involve hundreds of hours of computing time, even on EDSAC 2, but the outline of the structure of myoglobin (a model of which Dr. Kendrew showed) has now been determined. The molecule consists of a long chain of amino-acids twisted round on itself and compressed to look like something by Henry Moore— a truly formidable system. Current work on EDSAC 2 is now being directed towards the refinement of this structure to reveal greater detail, with the eventual object of resolving individual atoms. The later stages of this work will demand the use of very fast machines with very large storage capacity.

Dr. Kendrew emphasised that the crystal of myoglobin was, by biological standards, a comparatively simple structure. He showed slides of the structures of the tobacco mosaic virus and of the poliomyelitus virus. The latter looks like a collection of ants' eggs, arranged roughly spherically, each egg being as large as the myoglobin molecule. Determination of its structure by the methods outlined by Dr. Kendrew will involve very prolonged and complicated calculations indeed. He felt confident, however, that it would eventually be possible to discover the general principles on which these and other very complex molecules are built, and so to obtain a fuller understanding of the chemical processes taking place in all living cells. Such understanding of the basic nature and functioning of living matter is not only of the greatest intrinsic interest, but will also find far-reaching application in the treatment of disease and in the development of industries concerned with the production of food and other natural substances.

On the technical requirements of machines and equipment required for calculations of this nature, Dr. Kendrew described various ways in which further mechanisation is being introduced in his procedures, such as automatic recording of patterns and simplification of the display of results. The latter point raised lively discussion on possible methods of presenting structures in three-dimensional array with current apparatus and equipment.

* * *

SESSION 7—USING MAGNETIC TAPE

This symposium on experiences with the use of magnetic tape gave delegates much useful information on reliability and other factors found so far in this country. The speakers emphasised that these experiences were personal to their own installations and should not be taken necessarily as the general rule. Principle speakers were Mr. C. A. Wilkes (*Imperial Chemical Industries Ltd., Dyestuffs Division*), Mr. L. Griffiths (*Rolls Royce Ltd.*), Mr. P. B. Livesey (*Newton, Chambers & Co. Ltd.*) and Mr. C. B. Griffiths (*Babcock and Wilcox Ltd.*); the chairman was Mr. D. H. Rees (*Member of Council*).

Troubles with Faulty Tape

A survey of the types of fault one could have with a magnetic tape system was given by Mr. C. A. Wilkes. Some faults could be described to the tape itself, which may be of bad material; they had had difficulties with

L. Griffiths, P. B. Livesey, D. H. Rees (session chairman), G. B. Griffiths and C. A. Wilkes before the symposium on magnetic tape experience

one batch. In their installation they used pre-addressed tape, and they had found on occasion that the tape was badly addressed, the addresses being too close together. It was also possible for the tape to break or snap; the real cause of this had not been established clearly.

On the mechanism itself they had had some trouble with the servomechanisms, which was traced to deterioration of the rubber gasketing and consequential loss of vacuum. This fault was originally ascribed to the micro-switches, which were therefore adjusted, and they then had some difficulty before the system settled down again. In electronic faults, there had been a series of buffer store troubles, with parity failure. Nickel delay lines do not like heat, and their tape storage cabinet was not cooled. As Mr. Wilkes put it, on last year's warm day in Manchester, the room temperature reached 80 degrees, the delay lines heating to 90 degrees and going out of action.

They had only had one catastrophic failure at the accounting month end. The engineers discovered a number of faults, including dry joints and imperfect joints; it was difficult to discover which precise fault or combination of them had caused the difficulty. But Mr. Wilkes emphasised that they had never experienced wrong information being written on a tape without a signal of error.

Dealing with storage of tapes, he said that they kept their tapes in an air-conditioned cabinet, but the engineers' test tapes were not subject to any special precautions, and he wondered whether air conditioning was not an unnecessary luxury. He described fully the system of identification of tapes and protection against their incorrect use. This relied on a label system and a type-identification for each program written on the tape; further, each tape wrote on itself whether it was live or dead. They had more ambitious checks in mind but they had not so far experienced any difficulties in identification.

From their own experience, he also advised some quality tests on new tapes before use, both by visual inspection, to ensure that it was not creased and was properly spooled, and also by writing all over it from punched cards to test the validity of the information.

* * *

Uses of Tape Storage

Applications of magnetic tape storage were classified by Mr. L. Griffiths into four classes. His company used magnetic tape approximately 80% for technical work and 20% for commercial. Firstly, there were large areas of work, in an installation operating on a service basis to other departments, where many jobs could be read in at one loading, thus avoiding the set-up time of individual programs; a supervisory control system called in the right program for each particular job. Secondly, in processing many engineering calculations it was necessary to hold a large volume of data, which was only practicable with magnetic tape. Thirdly, for standard commercial processing, they had found the need to hold a large volume of data in storage. Fourthly, production control problems required large reference libraries of data.

A possibly unconventional use of tape in his organisation was in connection with the calculation of aero-engine performance points, by complicated patterns of iterative loops. Blocks of data were stored on library tapes and suitable blocks for the particular calculations required were then re-written on to working tapes for the particular problem.

They have devised a system for controlling the use of tapes by writing a block of three control words on to each tape. These covered such items as a record number (unique for each record), a data reference code, a tape content number (unique for a file of data whichever tape it is on), a tape reel number (unique for each reel) and cross-referencing to other records. They also maintain a card index system for all reel movements; in part this is a punched card record automatically produced at the end of a computer run. The full indexing and reference procedure was incorporated in all programs, so that the system, they felt, was almost foolproof.

While they had experienced errors, their practice was to program each job so that errors did not normally stop the process, but left an error trail, so that no time was lost. They had also devised standard error checks on standard procedures for rapidly tracing errors.

Tapes were stored in the computer room, which was air conditioned and maintained at a constant temperature of 70° and a humidity of between 40% and 60%. If the humidity rose to 70% for any period they found that the acetate coating tended to gather on the reading heads. Almost all tapes which were in use 2 years ago were still accurate. Some were showing signs of tape wear as a result of hard usage on engineering applications. They had devised routine tests for suspect tapes by programming the machine to print out the locations of bad areas.

* * *

Magnetic Film Reliability

The reliability of magnetic film was described by Mr. P. B. Livesey; his company have found it generally reliable, and he made the important distinction that with his equipment the read/write heads were not in contact

with the film. In one year of operation to June 1959 they had only 23 detected faults with their magnetic film equipment resulting in any loss of production; this excluded any found during the $1\frac{1}{2}$ hours daily maintenance.

The largest number of faults (12) was due to dry joints; five of these were probably due to the same joint. The other faults were due to valve failures (4), mechanical faults (3), one crystal failure and one fault on a nickel delay line; two faults were undiagnosed.

The general picture was therefore that reliability was good, but when a fault did occur their experience was that it took some time to diagnose and put right; the average down-time for the machine on the above faults was approximately $2\frac{1}{2}$ hours; on the faults other than those due to dry joints, however, the average was about $1\frac{1}{2}$ hours. At present the machine was still mainly under development and the jobs currently being run had a low ratio of film use, so that the figures given did not necessarily represent those which might be found on full usage of the tape units.

With regard to the film itself, they had found loose films (for which the main cure would seem to be good operating) and some had been returned owing to pin-holes in the oxide coating. They had no special air-conditioning arrangements for storing films and, even in the centre of an engineering works, had no troubles with dust. The spools could be easily bent if mis-handled.

They had not yet built up a system for control or identification of tapes, as so far they had only two jobs running, one for mechanical engineering and one for payroll.

* * *

Other Tape Applications

Mr. C. B. Griffiths described some routine uses for engineering applications of magnetic tape. They have had four tape mechanisms since January and planned to add stock control to the present uses. So far they have only limited experience, but they used magnetic tape wherever possible to gain more experience, even if the job did not perhaps fully justify it. In the engineering field they had 51 regular production programs. The 18 largest were held on one reel, called in as required by a (paper) steering tape; they consider this faster than reading paper tapes and it avoids risks from accidental tearing. They have had no tape failures so far.

Another application was to hold a long program which would more than fill the computer drum. By holding it on magnetic tape they could call it into the machine in two parts. They also used tape storage for the large volume of data necessary for pipe and other matrix type of stress calculation. Another use was for output, as they had found that magnetic tape was more accurate than paper tape punches. Again, it was used by programmers for storing partially developed programs, avoiding little bits of paper tape being lost. The stock control job had now been programmed and run satisfactorily on test; they were only waiting to clear the precise form of printed output with management.

On the tape itself, they had found that pre-addressed tape was not always accurate and at first had had a number of unsatisfactory tapes; later replacements showed an improvement. They had found it advisable to clean the read/write heads daily, as in the early days oxide deposits were causing some trouble. They had not yet lost any regular information on any tape, and the bell had so far only rung twice, on each occasion due to a fault in the mechanism. The master program tape referred to earlier had now run more than 1,250 times, without any trouble.

* * *

Discussion Points

In the discussion which followed, Dr. J. M. M. Pinkerton (*Leo Computers Ltd.*) gave details of the DECCA units now operating with LEO 2, drawing attention to the improved operation where the heads were out of contact with the tape. This point was also made by Dr. M. V. Wilkes (*Cambridge University Mathematical Laboratory*) who stated that on EDSAC 2 the heads had been adjusted to be out of contact with the tape.

The recovery of information lost on tape breakage was referred to by Mr. W. L. G. Absalom (*Albert E. Reed & Co. Ltd.*). While the steps to be taken depended to some extent on the type of information lost, he suggested that this could be done by—

(*a*) keeping a copy "last" tape and using that, or
(*b*) up-dating the previous tape again, which meant that it must have been retained, or
(*c*) returning to the original record.

This meant that on all jobs there should be a sufficient waiting time before re-use of tapes, and certain backing data should similarly be retained.

Mr. R. A. Fairthorne (*R.A.E., Farnborough*) suggested that the only reason for using magnetic tape at all as a part of a high-speed computer was that because no other device was at present available. He forecast that in 5 or 7 years' time other forms of storage would have replaced it so that current endeavour in the field of magnetic tape should be considered as a short term expedient only.

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SESSION 8*A*—PRODUCTION CONTROL

Two papers were given in this session. Mr. J. Harling (*Urwick Orr and Partners Ltd.*) described models of stock control and production scheduling, and Mr. F. Bryen (*International Computers and Tabulators Ltd.*) gave further information on the introduction and establishment of a system of computer production control in one of I.C.T.'s light engineering factories. Mr. R. H. Tizard (*London School of Economics*) was in the chair.

Warehouse Stock Control

Mr. Harling outlined the mathematical model of a problem in stock control of a warehouse. This would involve four possible combinations of conditions, and the model required to analyse a particular case would represent one or more of these. The four conditions were combinations of either determinable or uncertain demand, associated with either determinable or uncertain supply.

The uncertainties of demand could be summarised by calculating the mean and standard deviation of the frequency distribution of the quantities demanded in successive unit periods. The uncertainties of supply were represented by a frequency distribution of the delay times between ordering and receipt into stock.

J. Harling and Francis Bryen, with session chairman R. H. Tizard (centre), after giving their papers on production control

Where, however, the input to the warehouse was produced within the organisation, the solution would be simplified by re-ordering at constant time intervals. Given the mean values and the standard deviations from the frequency distributions, calculated from past records of demand, supply delay and production lead times (also the forecast demand and level of protection required against the risk of running out of stock), a mathematical model could be used to calculate the ideal stock level, re-order interval, etc.

The contribution of the computer was mainly in the handling of a large number of detail entries. In the more complicated models it was now possible to attempt a more satisfactory solution, based on calculated probabilities, than would be possible with manual routines.

* * *

Evaluating a Production Control System

The production control system in one of I.C.T.'s own factories has been described before (at last December's Computer Symposium in London, for example). The experiment has now gone far enough for some preliminary appraisal to be made of its success and Mr. Bryen outlined these. The company regarded the experiment as sufficiently successful for it to be extended to two other factories; the original experiment was started without regard to achieving direct economic savings in the medium size factory concerned. It was intended merely to prove or disprove theories on the application of a computer to production control in a factory which could quickly be re-controlled if the system was not satisfactory.

During introduction of the system it was found that the planners had been far too optimistic in their original estimates for the time required to reach a settling down stage; it was a better proposition to check thoroughly all basic data before operating the new system than to allow the new system to throw up errors in data. In planning the system, it is vital to ensure that the full effects of whatever form of production planning was in use previously have been appreciated and catered for in the initial planning of the new system. Finally, it is essential to ensure that training programmes are sufficiently comprehensive to ensure smoothness during the introductory stages of such a system.

In spite of the upheaval of a new system, and the fact that it was a "guinea-pig" one, the new procedure shows certain specific advantages over the old one. For example, the total number of items in short supply during the period has been reduced from approximately 500 to only 30. Production per man-hour worked has increased marginally (by an average of slightly under 2%). Part-ordering and split-batching have been reduced appreciably and the work-in-progress level is considerably lower.

Partly as a result of reducing the total number of items in short supply, the value of finished stores and stock has increased slightly; it is considered that the balance of stock availability is better than hitherto. While it is too early yet to expect the "forward" look in manufacturing control to show substantial advantages, this concept in practice is making the whole task of controlling stocks a very much easier one than hitherto.

* * *

Before his paper on the inversion of matrices: A. S. Householder (right) with session chairman E. T. Goodwin

SESSION 8*B*—INVERSION OF MATRICES

In a parallel session to the one on production control, Dr. Alston S. Householder (*Oak Ridge National Laboratory, Tennessee*) gave what he termed "some remarks" on the inversion of matrices. The Chairman was Dr. E. T. Goodwin (*National Physical Laboratory*).

Describing a method of assessing the value of various general methods, with the object of drawing attention to the pitfalls that exist, Dr. Householder described an argument that indicated that the method of rotation for inverting a matrix would be more stable than the elimination method. He described matrix inversion in terms of multiplication by a particular class of "elementary" matrices and showed how many well-known methods can be included in this description. By using hermitian unitary elementary matrices he evolved a method which he showed to be almost identical with a well-known method due to Dr. Givens of the Oak Ridge Laboratory. He then considered the relative stability of these methods with reference to various possible "condition numbers," but confessed that the subject still required further study.

During the discussion Dr. W. Kahan (*Cambridge University Mathematical Laboratory*) raised the question of the relationship between errors in the results and equivalent errors in the data. This led to a lively exchange in which Dr. J. W. Carr III (*University of North Carolina*) said that cases of ill-conditioned matrices could not be just ignored; they appeared frequently and solutions were definitely wanted.

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The Chairman pointed out that in some cases the data are exact, so that an exact solution would be meaningful, but suggested that otherwise the onus should be put on the originator of the problem to show why the matter was worth pursuing. Dr. Kahan said that in his opinion the only satisfactory way of obtaining high precision in such results was to solve repeatedly, using each time the residuals from the previous iteration. Often, however, such as in the compution involved in least-squares fitting, an approximate solution is good enough in ill-conditioned cases.

Dr. M. Goto (*Tokyo Electro-Technical Laboratory*) described some unpublished work by Professor Takahashi at the University of Tokyo. He had evaluated the determinants of matrices having integer co-efficiencies by using modulus arithmetic, repeating the calculation with a number of different bases which are mutually prime.

Mr. R. K. Livesley (*Cambridge University Engineering Laboratory*) said that he had found difficulty in using the method of conjugate gradients with sparse matrices which, although having elements mainly around the main and diagonal, were sometimes rather ill-conditioned.

Mr. J. H. Wensley (*Computer Developments Ltd.*) said that he had also used this method and had found that although in theory n iterations were sufficient, a further iteration was required to reduce the accumulated rounding error to a tolerable level. He had, however, been puzzled to find out that yet another iteration usually increased the error again. He then described the "synthetic" method which he had used to handle matrices with very occasional elements outside a diagonal band, by sub-dividing the matrix.

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SESSION 9*A*—SOME BUSINESS APPLICATIONS OF COMPUTERS

This symposium on business applications of digital computers was addressed by Mr. A. G. Wright and Mr. A. O. Bell (*The Imperial Tobacco Co.* (*of Gt. Britain and Ireland*) *Limited*) and Mr. C. W. Mallinson (*Deputy County Treasurer, Cheshire County Council*); Mr. H. W. Gearing (*Member of Council*) was in the chair.

Sales Invoicing and Analysis

The main application on Imperial Tobacco Co's. LEO 2 was sales invoicing, accounting and analysis for 38,000 customers, to occupy about half the total available time on the computer. This application was chosen because of the large number of people employed.

The job had been re-surveyed in 1954 when it was shown that under orthodox methods no improvement could be made on conditions in 1934; this made use of fast electric typewriters. Before selecting the machine, the company demanded availability for 4½ hours daily, Monday to Friday, starting at 8.30 a.m. each day, that the system should be capable of continuing the execution of 5,000 orders each day on the day received, that the invoice should be presentable (a SAMASTRONIC stylo-type face is used for output), and that as much of the job as possible should be covered, with sufficient packing documents being issued.

In addition to this job, they were planning to put payroll and other applications on the machines: 12 programs had now been written. They also intend to produce various

After the symposium on business applications: A. O. Bell, A. G. Wright, H. W. Gearing (session chairman), and C. W. Mallinson

statistical analyses of sales additional to those provided under the old system.

The main invoicing run checked that the customer had paid the last account and tested his credit limit, determined the terms for quantity discount and for any additional discounts relative to the period of payment, tested a number of conditions (such as the total quantity of book matches that could be included under the Railway safety regulations, and the company's own security limit on the value of cigars included in any one order), determined the method of transport, selected the stock cases, provided totals for stock control, up-dated the customer's account and printed out the invoice. This operation took seven seconds for each customer which was considered to be too long; they were engaged in pruning the program to achieve some saving in time.

In the preparation of customers' statements, sales statistics were now prepared for each traveller's journey, covering the previous three accounting periods; this had not been possible under the old system and it had proved to be most valuable information.

An essential feature of the system was that management must be free to alter the selling policy. They regarded computers as optional equipment to the O. and M. man and considered that there was no particular merit in having a computer for the sake of having one.

Parallel running during installation showed a number of errors in the old system. Leo Computers Ltd. had written the programs, but I.T.C. had selected their operators and engineers from their own staff. About half the job was now being run and it had been extremely free from breakdown.

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Local Government Requirements

The experience of Cheshire County Council in installing a computer was described by Mr. Mallinson. Without means of auto-reproduction, they had had some difficulty in the initial raising of the master files and existing records. The amount of overtime and the strain on the staff had been under-estimated; this job cannot be done too far ahead, and it was carried out one section at a time. All programmers and operators had been found from their own staff. They were selected by aptitude tests and on their course results, these being correlated with working results. They had now started to train reserves of programmers, and internal audit staff had also been trained.

The main difficulty facing a local authority is the diversity of work and statutory requirements. In Cheshire their turnover is of the order of £40 million a year, with a payroll of 20,000 covered by between 30 and 40 negotiating bodies and involving 9 pension schemes.

The computer was received in May 1958 and they were now operating a payroll for 19,000, accounting and cost analysis, loan accounting, highways costing, 11 stores accounts, central repair department job costing, and payment of 5,000 invoices. The final programs were now being written for a complete accounting and budgetary control system (on the exception principle). By April 1959, the computer was occupied to 60% of one shift use: 35 people had been saved and the installation was now breaking even.

In local government generally, there were great variations in size, and there were many small authorities who could not justify their own machine. He suggested they should explore the possibility of sharing use, possibly with a neighbouring authority. Another difficulty was the scattered nature of the data origination; Cheshire covered 1,000 square miles. He would hope for some development, possibly by the G.P.O., in data transmission.

If it was possible to develop an ideal computer for local government, he would suggest that they required equipment based on the building block principle, so that different sizes of authority could build up the machine required. There was only need for a small amount of calculation but a large volume of input and output; program capacity should also be large, not less than 2,000 operations. Magnetic tape for data library purposes was of advantage, and there was also a need for random access.

Reliability was of the utmost importance. In their own experience, breakdown time had been of the order of 4% in each week of 48 hours switched-on time. Maintenance was in one piece of 5 hours each week. He would also like to see more in-built checking, simple and quick programming, minimum installation costs with in-built ventilation and cooling and, not least, a reasonable price.

* * *

SESSION 9*B*—SOLUTION OF HYPERBOLIC PROBLEMS

In a parallel session on a physical application, Dr. D. S. Butler (*Atomic Research and Development Establishment, Fort Halstead*) described a new method of computing solutions of hyperbolic problems in three independent variables on an electronic computer. Dr. R. A. Buckingham (*University of London Computer Unit*) was in the chair.

This paper concerned an application of a numerical method of solving the problem of the supersonic flow pattern around a delta-shaped model, such as in aircraft design. Dr. Butler described the technique by which he had calculated the stationary flow at Mach 3.5, and showed that his results are in reasonable agreement with the patterns observed around the model in a high-speed wind tunnel. The numerical technique makes use of the special properties of the bi-characteristic curves associated with such systems and their solutions, and allows solutions to be constructed in a step-by-step fashion. A special feature is that any boundaries or discontinuities that are present are treated exactly and are not "smeared" in any way.

Dr. D. S. Butler (right) with Dr. R. A. Buckingham (session chairman) outside the "boundaries".

This difficult calculation technique involved more than 100 hours of work on AMOS, the FERRANTI Mark I* computer at Fort Halstead. One particular problem in programming arose when the storage requirements were considered. During each step, the solution at a set of points regularly spaced over a non-rectangular two-dimensional region is stored in the backing store and interpolations between these points are carried out. These interpolations require access to groups of adjacent points, Unfortunately, these groups of points are two-dimensional and rapid access can only be gained to one-dimensional blocks of information in the backing store. Other problems arise because of the existence of curved free boundaries and because the large scale of the computation dictates that economy in storage space and computing time must always be considered.

In the discussion which followed, interest centred on the stability and validity of the method employed in circumstances other than those described. Whilst it appears that the method can be made stable under simple restrictions, it is not clear that it is valid for problems involving more complicated boundary conditions.

* * *

SESSION 10—ECONOMIC PLANNING BY COMPUTER

The last session of the conference was devoted to a paper on the use of computers for economic planning in the petroleum chemical industry, by Mr. G. S. Galer (*Shell Chemical Co. Ltd.*); Mr. R. L. Michaelson (*Council Member*) was in the chair.

The complexity of the petroleum chemical industry leads to difficulty in the formulation of economic marketing and manufacturing plans. The Shell Chemical Co. Ltd. has used linear programming techniques for this purpose, applying them to the varied activities of the Royal Dutch/Shell Group in most parts of the world.

The two economic problems which most frequently occur, and which are particularly amenable to mathematical analysis, are those of joint supply and of the allocation of scarce resources between alternative uses. A chemical plant may

produce two or three products in ratios which, due to the properties of the chemical reactions, can be varied only within certain strictly defined limits. Since these ratios do not necessarily coincide with the ratios of the market potentials for the products, a decision must be made, knowing the prices at which the products can be sold, as to the set of ratios at which the plant must be operated, and the proportion of the market potential which must be satisfied, in order to function most economically.

A group of petroleum chemical plants will produce as many as 50 final products from one basic material. In a given period, the operating possibilities of the plant complex are known, and it is known that certain sales potentials exist for the products. How should available resources be deployed in order that the company as a whole shall operate to the best advantage? There are, of course, many different ways of meeting a given sales potential, but it is necessary to find which operating programme will yield the lowest possible manufacturing cost. From experience, linear programming appears to be the most powerful tool in the solution of such problems, and this method consists in setting up a large number of equations which express all the possibilities of sales and production, together with an expression describing the profit gained from each combination of possibilities. One is then able to select by calculation the optimum solution to yield the largest profit.

Development of the Model

Since the model was first set up in 1955, it has gone through various stages of development and is now regularly used for the formation of optimum marketing and manufacturing plans. It has provided valuable information on profitability for management, and has shown how marginal profit could be substantially increased by a re-framing of marketing plans.

Chemical planning for production is carried out on two levels; a seven-year survey and a five-quarter operating programme. Linear programming is at present used within this framework—

(*a*) to produce truly optimum plans, used chiefly to set up annual budgets,

(*b*) to produce the regular five-quarterly operating programmes, which act as a check on the cost of policy decisions, and

(*c*) the day-to-day programme of economic work.

The President of A.C.M., R. W. Hamming, was guest of honour at the conference dinner

Most of this work has been carried out on the FERRANTI Mark I* computer at the Royal Dutch/Shell Laboratories at Amsterdam. Some other similar computers have also been used, and some work has been done on IBM 704 machines in Paris and elsewhere. On the Mark I* machine, these problems normally run for 5 to 6½ hours, while amendments take up 2 hours, depending upon their number and the extent to which they alter the structure of the problem. Flexibility of operation in Amsterdam has been greatly increased by magnetic tape units, permitting the storage of intermediate matrices and saving time on paper tape output.

Long Term Investigations

The most promising use of mathematical planning in the chemical industry is for long-term investigations. The Group's investment programme will bring many complex economic problems, most of which should be amenable to analysis; it is hoped that future models will continue to be linear, but some United States experiences suggest that this may not be so.

Experience so far has shown the difficulties of optimising in the short-term, when demand fluctuations from period to period may be important. It may be worth while eventually to attack this problem, of optimising across time-periods, by linking several matrices together with equations representing transfers into and out of stock. These block triangular matrices will contain up to 1,000 equations, and should be soluble on the new FERRANTI MERCURY computer being installed by Shell in London and expected to become available during 1959.

AUSTRALIAN CONFERENCE

The Australian National Committee on Computation and Automatic Control announces a Conference on "Automatic Computing and Data Processing in Australia" to be held on 24 to 27 May 1960, at the University of Sydney and the University of New South Wales.

Papers are now invited for consideration in the following broad fields: Commercial Data Processing; Construction and Logical Design (including Analogue Computers); Scientific and Engineering Computation; Scientific and Engineering Data Processing Techniques; and Equipment Offering in Australia.

It is expected that the volume of papers will be such as to require the holding of simultaneous sessions in different fields, thereby ensuring a specialised audience in each field.

Those interested in presenting a paper at the Conference are asked to submit, as soon as possible, a title and brief statement describing the classification under which the paper should fall. A summary (approximately 200 words) must be submitted by 1 February 1960.

Papers being submitted for reading at the Conference should be submitted as such to one of the professional journals for publication, since there will be no separate proceedings of the Conference published. This should be done prior to the Conference in order that preprints may be arranged. The Secretary will be happy to answer any enquiry concerning publication difficulties.

Enquiries may be made at any time and correspondence, papers and sundries should be marked "Attention: Papers Sub-Committee" and addressed to C. H. D. Harper, Secretary, Australian National Committee on Computation and Automatic Control, c/o The Institution of Engineers, Science House, 157 Gloucester Street, Sydney.

INTERNATIONAL CONFERENCE ON INFORMATION PROCESSING

PARIS 15–20 JUNE 1959

By M. V. Wilkes

This report on the UNESCO Conference was given by the Society's President at the opening of the Cambridge conference on 22 June 1959.

The UNESCO conference was attended by approximately 1,800 delegates from 37 countries. The principal countries participating were:

France	*479 delegates*
U.S.A.	*408 ,,*
Germany (E. and W.)	*217 ,,*
United Kingdom	*164 ,,*

There were 38 Russian participants and 16 from Japan. The conference included parallel sessions and was held in the new UNESCO Building, except for the opening session which was held in the Grande Amphitheatre of the Sorbonne.

Sixty papers were presented in 11 main sessions. There were also 12 symposia which included 65 prepared contributions and many informal talks. A group from N.R.D.C. (United Kingdom) organised a debate on the ALGOL *system of automatic programming notation. The papers at the main sessions came from:*

U.S.A.	*27 papers*
United Kingdom	*7 ,,*
Russia	*5 ,,*
Germany	*5 ,,*
France	*5 ,,*
Japan	*4 ,,*
Netherlands	*2 ,,*
Switzerland	*2 ,,*
Italy	*1 ,,*
Israel	*1 ,,*
Czechoslovakia	*1 ,,*
	60

The photograph above is of the new UNESCO building, showing the main secretariat building and the conference hall (right). It is reproduced by permission of UNESCO (photo by Dominique Lajoux).

Origin of the Conference

The conference had its origin in an approach made by the Joint Computer Committee in the United States to the Director General of UNESCO. This approach was the culmination of a good deal of preparatory work. It was the result of a widespread and growing feeling among people in the United States interested in digital computers that the time was ripe for an international conference at which progress could be reported and ideas exchanged by workers from many countries. The idea was taken up enthusiastically by UNESCO and the necessary preparations were begun by the Department of Natural Sciences, of which Professor Auger was at that time head. Professor Auger was later succeeded by Professor Kouda of Moscow University, but nevertheless continued to take charge of the organisation of the conference. The Executive Secretary of the conference was Monsieur J. A. Mussard to whom great credit is due. UNESCO had already held a very successful international conference on radio isotopes, and this provided the model on which the information processing conference was based.

UNESCO realised that they could not run a conference without advice, and they accordingly established an international committee of consultants of which I was one. This committee held four meetings, some of the members coming from as far afield as the United States and Japan. Travelling expenses accounted for an appreciable part of the budget of the conference, but it is only by bringing people together to meet round a table that international enterprises can be successfully organized and UNESCO are quite used to spending money on travelling.

It was early decided that the conference should be concerned primarily with the use of digital computers and with their logical design. It was, however, later felt that it would be a pity to exclude altogether discussion of new engineering techniques which will make faster and better machines possible, and a special session devoted to these techniques was organised.

I seem to be the one they always put on conference committees and I am now becoming quite experienced. Any conference committee has a number of fundamental decisions to take. It must decide whether there shall be single sessions only or whether sessions on different topics should be held in parallel. It must also decide whether to make up the programme by issuing a general call for papers and then making a selection from what is offered, or whether to make it up by inviting selected workers in the field to contribute; as a further alternative, a combination of these methods may be employed. Finally, the committee must decide whether or not the papers are to be preprinted and issued in advance to members of the conference.

In the case of the UNESCO conference, it was decided that there should be main sessions running throughout the day on the following subjects:

Methods of digital computing (including numerical analysis).
Logical design of digital computers.
Common language for digital computers.
Automatic translation of languages.
Pattern recognition.
Machine learning.

It was decided that preprints of papers presented at the main session would be made available.

In addition there would be symposia on specialised topics which would be held during the afternoons in parallel with the main sessions. A co-ordinator was appointed for each symposium and he was free to arrange the programme as he wished, either by making use of offered contributions or by inviting people to contribute. The symposia turned out to be much more popular and important than had been altogether expected when they were planned. This was to my mind largely because they did not depend, as did the main sessions, on papers offered and written far in advance and were consequently fresher and more up to date; moreover, they included contributions from eminent workers in the field who would have been unlikely to make an unsolicited offer of a paper.

UNESCO Conference Organisation

You may be interested in some details of the organisation of the conference, particularly as UNESCO encounters in its work technical problems not met by organisers of national conferences. Abstracts of papers were prepared in the four official languages of UNESCO, namely, English, French, Spanish, and Russian; in addition, translations into German were provided at the cost of the German government. Preprints of papers were issued in either English or French. Simultaneous interpretation between the four official languages was provided for the main sessions; no interpretation was originally planned for the symposia, but after the first day it was provided in response to public demand.

There were two organisational features that I had not met elsewhere which contributed greatly to the success of the conference. One was the issue each day of a duplicated journal containing news, latest information, and additions to the list of participants. The other was the appointment by UNESCO of seven "scientific secretaries." These were all scientists working in the computer field and who therefore understood the technical matter of the conference. During the conference their duties were to assist the chairmen in the conduct of the various sessions, to make sure that speakers had everything they required and that the interpreters were suitably briefed, and to provide liaison with the UNESCO Secretariat. They had spent some weeks in Paris before the conference began working on the manuscripts, and are staying on afterwards for a short period to finalise the copy for the conference record. Two of the scientific secretaries were from this country.

The New UNESCO Building

The conference took place in the new UNESCO building in Paris and was in fact the first conference to be held there. This building, and the controversial works of art which it contains, has attracted some attention, and you may like to hear what my impressions of it were. It was, I understand, designed by an international panel of architects of which Le Corbusier was one. It resembles the United Nations building in New York in that it consists of two separate buildings connected by a corridor. The larger of the two buildings contains offices for the Secretariat and is a fairly tall building for that part of Paris, containing seven or eight storeys. It is the part which is by far the most conspicuous in photographs of the building. Connected to it is a low conference building, one storey, or in places two storeys, high. This contains a large auditorium in which the main sessions were held, a number of smaller conference rooms, small committee rooms, a press room, and a buffet. The conference building is quite large, although it does not appear so when you see it empty. Nearly 1,800 people attended the conference and I thought that we were going to have a very uncomfortable time; in fact there was plenty of space. The corridors and lobbies seemed to expand like india rubber to absorb the crowds.

My Impressions of the Conference

Naturally I can tell you only about the sessions and symposia which I attended. No doubt I missed a great deal that would have been worth hearing, and another person who had made a different choice from the available alternatives might give you quite a different report. I started out on the first day by attending the main session on some specialised aspects of numerical analysis, but I soon switched over to a symposium on the influence of very large memory designs and capabilities on information retrieval. Much interest was shown in this symposium, although most people agreed afterwards that the discussions did not seem to lead anywhere. Perhaps this was only to be expected in view of the speculative nature of the subject.

The section on logical design spread over three sessions. I was rapporteur of this section and contributed an opening lecture. The first session contained, apart from my lecture, five papers on various aspects of time sharing, and although I found the papers interesting I cannot say that there was much that I had not heard before.

There was a good deal of discussion at the conference about common symbolic languages for digital computers. In the main session on this subject there was an account of a conference recently held in Zurich at which an international computer language known as ALGOL was discussed. The aim of its promoters is that this language will become generally used both as a means of communication between programmers in the scientific field and as an input language for machines. As many of you know the British Computer Society has a research committee on standardisation of scientific programming notation and this committee has, through one of its members, been in touch with the ALGOL committee. Proposals for standardisation always lead to a certain amount of high feeling, and perhaps one of the most useful functions served by the UNESCO conference was that it provided an opportunity for such feelings in the case of ALGOL to be ventilated, and for misunderstandings to be cleared up. In response to requests, a special discussion on ALGOL was arranged to take place one morning. It was felt that a firm and able chairman was needed and Dr. Taub, of the University of Illinois, was pressed into this role, which he filled with distinction. The main subjects on which the discussion centred were whether there should not be two separate languages, one for communication between programmers and one for input to machines, how many characters should be used to express the language, whether they should all be written on the same level, and so on. I thought the discussion served a very useful purpose and I came away with a much clearer understanding than I had before of what ALGOL stands for. In particular, the discussions showed that there is a good deal of backing in the United States for ALGOL. The more people who can join in an international programme the more effective it becomes, and I believe that all members of this society who are interested in scientific computation should study the ALGOL proposals carefully.

It is a natural transition from symbolic languages for machines to machine translation of human languages. The first paper in this session was read by Dr. A. G. Oettinger, of Harvard University. Perhaps I am biased in Oettinger's favour, since he was for one year a pupil of mine, but in the one session on language translation that I attended I thought his paper stood out. Work at Harvard has been concentrated on the establishment of an automatic Russian-English dictionary; this is now completed, at any rate in its first form, and the group is beginning to study the syntactical problems encountered in using it for translation. Other groups appear to have concentrated on syntactical and grammatical problems first. At Paris, Oettinger generously offered to make his dictionary, which is stored on six reels of UNIVAC magnetic tape, available to other bona fide groups working in the field. I venture to predict that the Harvard dictionary will play a decisive role in the development of Russian-English machine translation.

The highlights of the conference from my point of view were the symposium on logical organisation for very high speed computers, and a special session held on the Saturday afternoon on computer techniques of the future. This session, unlike the other sessions, was not built up out of offered papers, but was in charge of Dr. Auerbach by whom all the contributions were solicited. I have already mentioned the advantages of not relying exclusively on offered contributions, and it is not, I think, an accident that the most interesting

contributions to the conference were to be found in the symposia and in this special session of invited papers.

In the symposium on very high speed computers, Dr. Kilburn, of Manchester University, spoke about MUSE. Everyone was, I think, impressed by the high quality of the work he described. As you will see from the programme of this conference, Dr. Kilburn is repeating his contribution for our benefit. Dr. Kilburn was followed by Dr. Taub of the University of Illinois, who gave an up-to-date account of the now famous Illinois project. Design work on this project is now nearly complete and full-scale construction will start shortly. There was a contribution by Dr. H. Billing on computer activities in Germany but, while what Dr. Billing had to say was of interest, the machines he described did not come into the same speed range as the other machines. Finally there were contributions on the LARC and STRETCH systems, not by representatives of the manufacturers, but by Dr. Fernbach, of the University of California, and Dr. Lazarus, of the Los Alamos Laboratory, who had been closely concerned in the specification of the respective systems.

At the special session on computer techniques of the future, many people attending the conference heard for the first time the sad news of the death some weeks ago of Dr. Dudley Buck of M.I.T. Dr. Buck was to have presented a paper by himself and K. R. Shulders on an approach to microminiature printed systems. The paper was completed before his death and it was presented by Mr. Shulders. I heard Dr. Buck speak about the work at the Joint Computer Conference last December, and some of you may have heard my enthusiastic reports on its brilliance and promise. The computer field has suffered a great loss in that of Dr. Buck.

The session also included excellent papers on thin magnetic films, cryogenic components, and microwave techniques of the parametron type. These papers contained much information that had not been made public before and anyone interested in the engineering design of computers should read them. They were all preprinted and put in the hands of members of the conference along with the other preprints.

The Exhibition

The Joint Computer Conference in the United States always has an exhibition associated with it. It was natural, therefore, for an exhibition to be held in conjunction with the UNESCO conference. There were in all about thirty stands and eight countries were represented. From this country, *National-Elliott*, *S.T.C.*, and *Creed* were exhibiting, but the British manufacturers as a whole were not present. The main reason for this, no doubt, was that the invitation to participate came just at the time when they were making the very large effort of mounting the exhibition at Olympia and they did not, therefore, feel that they could undertake the commitment of exhibiting at Paris so soon afterwards. This was very understandable, but when the time came one could not but feel sorry that Britain was not more fully represented at the Paris exhibition.

There were no fewer than four exhibitors from Japan, and one of the features of the conference generally was the emergence of Japan as a country to be taken account of in the computer field. Sixteen Japanese came to Paris for the conference and I was left with the impression that Japan is making a distinctive contribution. The Russians found it too difficult to exhibit, but contributed a number of papers to the general sessions of the conference. Evidently a good deal of effort is going into computer development in Russia, but the Russian papers I heard were not very exciting.

Exhibitors at the conference naturally wished for an opportunity to talk about their wares and arrangements were accordingly made for a series of lectures to be given on the last two days that the exhibition was to be open—in fact, these lectures are being given today and tomorrow. Some of the titles looked very interesting, but naturally I was unable to hear any of the lectures.

International Organisation

While UNESCO were happy to organise this conference, they would not be able to organise another conference on the same subject. Discussions have been taking place, therefore, with a view to the setting up of an international organisation which can take care of future conferences. It now appears certain that such an organisation will be set up under the name "International Federation of Information Processing Societies" and it is much to be hoped that our society will participate. The present feeling seems to be that the next conference should be held in about four years' time. If all goes well the new federation will come into existence on 1 January 1960 and its first task will be to consider where the next conference should be held.

ACCESSION TO LIBRARY

The proceedings of the Computer Applications Symposium October 1958 (*Armour Research Foundation of Illinois Institute of Technology*) included: Automation of Banking Procedures, Information Retrieval, Data Processing for Defence, Remote Input and Output, Character Recognition Devices, Control of Machine Tools, Computer Sharing and Automatic Programming.

THE BRITISH COMPUTER SOCIETY LIMITED
ANNUAL REPORT 1958–59

The Society has had a successful year, and many of the plans laid during the first year of its existence have now begun to bear fruit. This report formally covers the year ending 30 April 1959, but the decision to hold the Annual General meeting in September this year, instead of June, has provided the opportunity to mention certain events of general interest to members which have occurred since the end of the Society's year.

Membership

The membership of the Society has shown a satisfactory expansion during the year, as is shown by the following figures:

	30 April 1958	*New members*	*Resignations etc.*	*30 April 1959*
Ordinary	1,182	716	113	1,687
Institutional	38			89
Associate	80			125
Student	—			2
	1,300			1,903

Regional Branches

During the year ending 30 April 1959 four new branches were formed in Belfast, Leicester, Liverpool and Middlesbrough, and an overseas branch was formed in Holland. Discussions are in progress on the formation of branches in Bristol and in Australia and India.

Finance

As will be seen from the accounts the excess of income over expenditure for the year ending 30 April 1959 was £141. This relatively satisfactory state of affairs has not been achieved without some effort. It was apparent at the end of August that the over-optimistic forecasts of membership expansion which had been made when the 1958–59 Budget was prepared were unlikely to be fulfilled, and that in consequence if this Budget was adhered to the Society would find itself in financial difficulties before the end of the financial year. It was therefore decided that a reorganisation of the office would be necessary. This reorganisation has resulted in considerable economies and the new organisation is now working smoothly and efficiently.

The Council is pleased to report that since the end of the financial year a donation of £500 has been received from the E.E.A./O.A.B.E.T.A. Joint Committee which was formed to conduct the Computer Exhibition and Symposium. They wish to place on record their sincere appreciation of this generous gift for the furtherance of the objects of the Society.

Members have already been informed that the Society was successful in gaining income tax relief for the subscriptions of members under Section 16 of the Finance Act, 1958. The Society has now also been successful in securing relief from income tax of investment income with effect from 10 March 1959.

Meetings

Twenty-two meetings were held in the London area. Of these, 16 were held at the Northampton College of Advanced Technology, 5 at the Institution of Electrical Engineers and one at the Rudolf Steiner Theatre.

At all but two of the meetings the contributors were from this country. There were three visiting speakers from the U.S.A. and it is interesting to note that they drew the highest attendances, each meeting having an audience of well over 200. The average attendance at the N.C.A.T. for the evening meetings was about 70 and for the afternoon meetings about 40.

Council wish to place on record their great appreciation of the generous facilities provided for the holding of meetings by Northampton College and to the Institution of Electrical Engineers.

Publications

Both *The Computer Journal* and *The Computer Bulletin* have had a successful year. In addition to its circulation amongst members the *Journal* at the end of April 1959 had 514 regular subscribers, many of them from overseas, and the *Bulletin* had 169 regular subscribers.

It is gratifying to note that the *Journal* is now self-supporting. The high standard of papers has been maintained. It is hoped that members will continue to use the *Journal* as a medium of publication for their more important contributions. Papers on the development and use of computational machinery in the sphere of business applications are particularly required.

Arrangements have been made for members of The Association for Computing Machinery, L'Association Francaise de Calcul and the Computer Society of South Africa to subscribe to the publications of the Society at reduced rates.

Annual Prizes

It has been decided to offer two annual prizes for the best two papers published in *The Computer Journal* or *The Computer Bulletin*, one of the papers to be on a business application of computers and the other on a mathematical, scientific or engineering application, or on logical design. Each prize will be of 20 guineas.

The first competition will cover those papers published between April 1959 and April 1960, inclusive. The competition will be judged by the Editorial Board, whose decision will be final and whose members will not be eligible for award.

Papers to be considered for publication in this period must be received by one of the honorary editors in their final form not later than 11 January 1960. Notes on the Submission of Papers are printed on page vii in the *Journal*, Vol. 2, No. 2 (dated July 1959 but delayed by the printing strike).

Cambridge Conference

The first conference of the Society was held in Cambridge from 22–25 June 1959. These dates were chosen so that it

would be possible for overseas visitors attending the International Conference on Information Processing, held in Paris by UNESCO the previous week, to attend our conference. Some 50 people from overseas did in fact attend, together with about 280 members of the Society and others from this country. Applications to attend exceeded the accommodation available and it is regretted that a number of members could not be accepted.

The conference was adjudged a great success by all who attended. A very high proportion of the conference members took part in each session and there was surprisingly little falling off in attendance in the later stages, despite the extremely warm weather.

Eight main sessions and five symposia were held on a wide variety of subjects. A full report appears in *The Computer Bulletin*, Vol. 3, Nos. 3–4, and many of the papers will be published in full in *The Computer Journal* or *The Computer Bulletin*.

In view of the success of the conference the possibility of holding further annual conferences is being explored.

Electronic Computer Exhibition and Business Symposium, Olympia, 1958

The exhibition and the associated symposium were universally considered a great success. Members of the Society participated in arranging the symposium, and the Society had a stand at the exhibition, which served to bring the existence of the Society to the notice of many of those attending the exhibition, and was instrumental in recruiting a number of new members.

Study Groups

Of the 20 groups originally formed, 14 continued actively and regularly throughout the session. The average number of meetings held by these groups was 7, and the average attendance was 11. The most successful groups were:

(*a*) Input/Output.
(*b*) General accounting.
(*c*) Production control.
(*d*) Programming and Auto Code.
(*e*) Examination of actual computer installations.
(*f*) Specification of a small scale EDP installation.

Education Committee

With the assistance of the Committees of the Regional Branches this Committee has been surveying the available courses on computing and allied matters, and hopes to issue an annual list of such courses. The Committee has also been considering aptitude tests for computer personnel and a note on this subject has been published.

Research Committee on the Standardisation of Scientific Programming Notation

This committee, which was set up in June 1958, has been actively engaged on the problem of developing a common language in which to express computer programmes, and has already published a note in the *Bulletin* on the subject (Vol. 3, No. 1). In view of the very different requirements of scientific and business applications it has confined its attention to the former, but a parallel committee to deal with business applications has now been set up. The subject is of great interest and importance at the present time in view of the active development in many countries of computer languages and autocodes, and the great advantages which will accrue if international agreement can be reached on a common language which is simple, flexible and capable of development.

Glossary Committee

The Society has been co-operating with a Committee of the British Standards Institution in drawing up a glossary of Computer Terminology. This is now almost complete. The work originated with a request from the Provisional International Computation Centre for assistance in the compilation of a multi-lingual dictionary of data processing terminology, which was required for the 1959 UNESCO conference.

On behalf of the Council,
F. YATES,
Chairman.

20 *August* 1959

* * *

Changes in Council Membership

The following members of Council retired by rotation at the Annual General Meeting:

A. D. Booth
A, J. Bray
A. S. Douglas
S. Gill
D. W. Hooper
E. N. Mutch
J. E. L. Rotheroe
F. Yates

Council considered that it would be advantageous for the rotational scheme of replacement to begin to operate this year, and therefore only Mr. Hooper and Dr. Yates offered themselves and were nominated by Council for re-election.

Mr. R. G. Dowse was re-appointed to Council when he took up his duties as Honorary Secretary, and was also nominated by Council for election. Mr. R. M. Paine resigned as representative of the London Branch, owing to pressure of editorial duties for the *Bulletin*, but was nominated by Council for election as an elected member.

The other Council nominations for election were:

S. A. Brown
G. M. Davis
G. H. Hinds

No other nominations were received, and these members were therefore declared elected at the Annual General Meeting.

The Business Group have nominated Mr. P. V. Ellis in place of Mr. Rotheroe, and the London Regional Group Committee have nominated Dr. R. A. Buckingham in place of Mr. Paine.

* * *

THE BRITISH COMPUTER SOCIETY LIMITED

INCOME AND EXPENDITURE ACCOUNT

For the year ended 30 April 1959

1958 £	£	£		1959 £	£	£
			INCOME			
			Subscriptions			
3,163			1,607 Ordinary at £3 3 0			5,062
374			80 Ordinary at £2 2 0			168
340			89 Institutional at £10 10 0			935
84			125 Associate at £1 1 0			131
—			2 Student at £1 1 0			2
			1,903			
776			*Entrance Fees* 584 at £1 1 0			613
4,737						6,911
			The Computer Journal			
	99		Sales		1,521	
	333		Advertising		1,467	
	432				2,988	
	497		Less Costs		2,874	
(65)						114
45			*Deposit Interest*			24
4,717						7,049
			EXPENDITURE			
	1,676		Salaries and National Insurance		2,223	
	—		Office Rent and Rates		550	
	627		Printing and Stationery		959	
	520		Postage and Telephone		602	
	576		General Expenses		217	
	23		Depreciation of Office Equipment		146	
	—		Loss on Sale of Office Equipment		28	
	—		Legal Charges		81	
	31		Audit Fee		32	
	—		Public Relations		322	
	142		Council and Committee Expenses		216	
	3,595				5,376	
			B.C.A.C. Subscription		32	
			The Computer Bulletin			
		982	Costs	2,015		
		91	*Less* Sales	209		
		462	Advertising	1,088		
		553		1,297		
	429				718	
	—		Provision for Doubtful Debts—Publications		83	
	186		National Meetings		141	
	82		London Study Groups		47	
	205		Branch Advances and Expenses		481	
	111		*Incorporation Expenses*		—	
4,608						6,878
109						171
			PROVISION FOR TAXATION			
—			1957–58		20	
—			1958–59		10	30
109			EXCESS OF INCOME OVER EXPENDITURE			141

THE BRITISH COMPUTER SOCIETY LIMITED

BALANCE SHEET AS AT 30 APRIL 1959

1958 £	1958 £		Cost £	Depreciation £	Net £
		Fixed Assets			
117		Office Equipment at 30 April 1958	468	26	442
342		*Add:* Additions	278		278
459			746	26	720
17		*Less:* Depreciation		146	146
442			746	172	574
—		*Less:* Disposals	62	20	42
442			£684	£152	532
		Current Assets			
	125	Stock of Stationery		—	
	272	Stock of Publications		185	
	688	Debtors and Prepayments		1,106	
	255	Bank and Cash Balances		329	
1,340					1,620
1,782					2,152
		Less: **Current Liabilities**			
	915	Creditors and Accrued Charges		332	
	717	Amounts received in advance		1,499	
	1,632			1,831	
	—	**Provision for Taxation**		30	
1,632					1,861
		Net Assets Represented by the Accumulated Fund			
	41	Balance at 30 April 1958		150	
	109	*Add:* Excess of Income over Expenditure for the year		141	
£150					£291

Liability of Members

Note: The Society has no share capital, but in terms of clause 6 of the Memorandum of Association every member undertakes to contribute a sum not exceeding £1 in the event of the Society being wound up during the time that he is a member or within one year after he ceases to be a member.

On behalf of the Council,

F. Yates, *Chairman.*
J. Hough, *Treasurer.*

REPORT OF THE AUDITOR TO THE MEMBERS OF THE BRITISH COMPUTER SOCIETY LIMITED

I have audited the books and accounts of The British Computer Society Limited for the year ended 30 April 1959 and have obtained all the information and explanations that I considered necessary. Proper books of account have been kept and the foregoing Balance Sheet is in agreement therewith.

The said Balance Sheet and the annexed Income and Expenditure Account give the information required by the Companies Act, 1958, and give, in my opinion, a true and fair view of the state of the Company's affairs as at 30 April 1959 and of the excess of income over expenditure for the year ended on that date.

London
24 *August* 1959

E. F. Milne,
Chartered Accountant.

CORRESPONDENCE

Letters from readers are welcomed, and should be addressed to The Editors, The Computer Bulletin, Finsbury Court. Finsbury Pavement, London, E.C.2. The name and address of the writer must be given, but will not be published if requested.

Conversion from a Low to a High Radix

Sir,

Your readers may be interested in the following method of converting from a low to a higher radix.

I first came across this method when in the U.S.A., but as far as I am aware, it is little known in this country.

Yours, etc.,

K. TYLDEN-PATTENSON

Production-Engineering Ltd.,
30 *Waterloo Street*,
Birmingham, 2.

To Obtain the Equivalent of a Number Written in a Low Radix in the Notation of a Higher Radix

1. Subtract the lower radix base from the higher.

2. Working from the most significant end of the lower radix number, multiply the first digit by the difference between the two bases and subtract from the most significant end of the number. Always work in the notation of the higher radix. (*N.B.*—If the original number consists of a single digit, the number is the same in both radixes. If the original number consists of two digits, the remainder is the higher radix number equivalent.)

3. Multiply the remainder by the difference between the two bases and subtract from the remainder and the next most significant digit of the original low radix number.

4. Repeat 3 until a digit has been subtracted from the least significant digit of the original number. The final remainder is the equivalent of the original in the higher radix.

* * *

Example 1.—Convert 3745_8 to its decimal equivalent:

$$(10 - 8 = 2)$$

$$\begin{array}{ccccl}
3 & 7 & 4 & 5 & \\
 & 6 & & & (3 \times 2) \\ \hline
3 & 1\cdot & 4 & & \\
 & 6 & 2 & & (31 \times 2) \\ \hline
2 & 5 & 2\cdot & 5 & \\
 & 5 & 0 & 4 & (252 \times 2) \\ \hline
2 & 0 & 2 & 1 &
\end{array}$$

$$3745_8 \equiv 2021_{10}$$

Example 2.—Convert 11011_2 to octal notation:

$$(8 - 2 = 6)$$

$$\begin{array}{cccccl}
1 & 1 & 0 & 1 & 1 & \\
 & 6 & & & & ((1 \times 6)_8 = 6_8) \\ \hline
 & 3\cdot & 0 & & & (11_8 - 6_8 = 3_8) \\
 & 2 & 2 & & & ((3 \times 6)_8 = 22_8) \\ \hline
 & & 6\cdot & 1 & & (30_8 - 22_8 = 6_8) \\
 & & 4 & 4 & & ((6 \times 6)_8 = 44_8) \\ \hline
 & & 1 & 5\cdot & 1 & (61_8 - 44_8 = 15_8) \\
 & & 1 & 1 & 6 & ((15_8 \times 6_8) = 116_8) \\ \hline
 & & & 3 & 3 &
\end{array}$$

$$11011_2 \equiv 33_8 \equiv 27_{10}$$

N.B.—Binary to octal conversion is most easily carried out by grouping the binary number into sets of three bits and writing down the decimal equivalent:

$$\begin{array}{cc|ccc}
1 & 1 & 0 & 1 & 1 \\
 & 3 & & 3 &
\end{array} \qquad 11011_2 \equiv 33_8$$

Example 3.—Convert 11011_2 to decimal equivalent:

$$(10 - 2 = 8)$$

$$\begin{array}{cccccl}
1 & 1 & 0 & 1 & 1 & \\
 & 8 & & & & (1 \times 8 = 8)_{10} \\ \hline
 & 3\cdot & 0 & & & \\
 & 2 & 4 & & & (3 \times 8 = 24)_{10} \\ \hline
 & & 6\cdot & 1 & & \\
 & & 4 & 8 & & (6 \times 8 = 48)_{10} \\ \hline
 & & 1 & 3\cdot & 1 & \\
 & & 1 & 0 & 4 & (13 \times 8 = 104)_{10} \\ \hline
 & & & 2 & 7 &
\end{array}$$

$$11011_2 \equiv 27_{10}$$

N.B.—To carry out a binary to decimal conversion it is best to write down the octal equivalent of the number and convert from octal to decimal.

Example 4.—Convert 1011010011_2 to decimal:

$$(1 \quad 011 \quad 010 \quad 011)_2$$
$$(1 \quad 3 \quad 2 \quad 3)_8$$

$$\begin{array}{cccc}
1 & 3 & 2 & 3 \\
 & 2 & & \\ \hline
1 & 1\cdot & 2 & \\
 & 2 & 2 & \\ \hline
 & 9 & 0 & 3 \\
 & 1 & 8 & 0 \\ \hline
 & 7 & 2 & 3
\end{array}$$

$$1011010011_2 = 1323_8 = 723_{10}$$

CONFERENCES

Space does not permit us to publish reports of all the summer conferences dealing with computers and related topics. The following notes are based on reports by correspondents of some of those of general interest.

* * *

The UNESCO Conference

(*This summary of the UNESCO Conference was contributed by our correspondent in amplification of the personal impressions given by Dr. Wilkes in his paper to the Society's Cambridge Conference—reproduced on p. 53 of this issue.*)

Logical Design of Digital Computers: Dr. M. V. Wilkes (*Cambridge*) referred to the varying priorities which had preoccupied designers at various times. In scientific computers the aim had been to ensure that as much time as possible was spent on calculation and that time was not wasted by unnecessary accuracy. He gave the following landmarks of past developments:

(1) The stored program principle;
(2) Improved design of control units;
(3) Microprogramming (storage of routines frequently required);
(4) Memories for reading only;
(5) Time-sharing;
(6) On-line applications in control systems, both physical and managerial.

He summarised the problems of today's designers as:

(1) Storage systems are not fast enough to keep pace with the new faster arithmetic units;
(2) The need to cater both for automatic programming by casual users and full programming by those preparing work for routine runs;
(3) The requirements of floating-point operation for fast scientific work conflict with those for fixed-point operation where greater precision is required;
(4) Time is being lost by unnecessary precision, particularly in multiplication and division.

C. Strachey (*N.R.D.C.*) discussed time-sharing in large fast computers. His hypothetical machine and machines already in existence in America disclose that economies can be effected by a very large machine designed to perform several different jobs simultaneously. The problems of design arise mainly in the facilities required for storage and access to programs and data and in the director mechanism to settle the priorities of the different jobs.

Two papers on the design of simple cost-limited computers for scientific work were submitted by Van der Poel (*Netherlands Post Office*) and Lehman (*Israel Ministry of Defence*).

At the other end of the scale, three authors from the *IBM Product Development Laboratories, Poughkeepsie*, who are developing a new computer system for the U.S. Government, described methods used to pack the maximum of information into the large units associated with that system for economy and speed of operation.

The special session, at the end of the conference, on computer techniques of the future, provided papers on new component elements now at the laboratory stage. These included storage elements of thin magnetic films (U.S.A. and Switzerland) for which no suitable switching system has yet been designed. Another development (cryogenic components) uses vacuum evaporated films of superconducting metals, which depend on precise levels of impurity, low temperature (storage in liquid helium) and very accurate measurements during construction. In Japan, the Parametron circuit has been developed, which can be made to oscillate in one of two subharmonic phases of the master phase of the "pumping current"; these two subharmonic phases are used to indicate the binary digits 0 and 1. Work is also being done on this in Munich.

Other techniques using "phase-locked oscillators" are under development by R.C.A. in America. These tendencies, together with printed circuits, etc., are making for smaller and smaller computers which obviously have an application in the ballistics field. For commercial applications, however, the arrival of the transistor and its successors, and the trend towards miniature circuits, raises problems of construction and maintenance which will require considerable training of operatives and maintenance personnel.

Methods of Digital Computing: The cumulative effect of rounding errors in extended calculations was discussed in papers by Wilkinson (*N.P.L.*) and other authors from Grenoble, Lausanne, Princeton University, University of California and University of Illinois. The approach varied from catering throughout for errors of the largest possible value, to one based on probabilities. A complementary problem arises when the successive values of a series, which have each been rounded within the capacity of the calculator, are expected to tend to "zero," in establishing when in fact "zero" is reached.

The development of high speed computers has made possible the solution of problems by iterative methods, some of which were long ago discarded from the manual computation viewpoint. Papers on applications in this category were submitted by Evans (*Manchester*) and other authors from France, U.S.A. and Germany.

Common Symbolic Language: Each type of computer has its own programming system and an organisation of internal storage space peculiar to itself. Attention is therefore being directed to the creation of a common international symbolic language in which problems could be summarised and subsequently translated into specific machine routines. The lead in this was taken by U.S.A. and Germany, but United Kingdom workers are now challenging the logic of their approach. The benefit of this work will accrue mainly to scientific calculations, but some work is being done on possible applications to business data processing.

Storage and Retrieval of Information: The discussions at several symposia centred on the design of coding systems and the need when coding data to anticipate the elements under which subsequent enquiries or references might be classified. The problem is to economise in storage space whilst preserving rapid access to stored data by reference to the codes which cannot be identified exactly with addresses of pigeon holes in the store. The competing claims of random access (storage on large drums, etc.) and the more economical sequential access (e.g. magnetic tape) were discussed, and several speakers referred to the need for practical trials of theoretical systems of coding and store addressing before conclusions could be drawn.

"*Machine Thinking*": Experiments carried out at Manchester, by Kilburn, Grimsdale and Sumner, and elsewhere,

indicate that by combining simple programs in a large digital computer, new programs can be constructed by the machine which are more efficient than the sum total of those fed in; the result would have taken a considerable amount of human thinking to create from first principles.

Character Recognition: The papers on electronic reading machines came from U.S.A. (3), Germany (2), and Japan. Some of the techniques involved are already being applied in the United Kingdom by Solartron and E.M.I., but the solutions so far advanced require printed or typed characters, the preparation of which could often be associated with the punching of cards or tape.

Automatic Translation: Work on this is being done at Harvard, Massachusetts Institute of Technology, Santa Monica, Tokyo, Moscow, London and Cambridge. The Harvard approach is aimed at processing Russian technical literature and uses a dictionary of 22,000 entries for over 10,000 words, stored on magnetic tapes. The Japanese machine uses four separate dictionaries stored on a large magnetic drum. The Cambridge school have adopted a different approach based on a thesaurus principle.

* * *

Structural Computing

A 3-day conference on the application of electronic computers to problems of structural engineering was held at Southampton University during the week ending 12 September 1959. The conference was organised by the Department of Civil Engineering under the direction of Professor P. B. Morice, and was attended by upwards of 100 delegates from universities, scientific establishments, and the civil and aeronautical professions. The following papers were presented:

- The history and development of digital computers, by Dr. C. M. Wilson (*Ferranti Ltd.*).
- The application of computers to relaxation problems, by Professor D. N. de G. Allen (*Sheffield University*).
- The economic use of digital computers, by Dr. D. M. Brotton (*Manchester College of Technology*).
- Influence coefficient methods of structural analysis, by J. C. de C. Henderson, A. D. Edwards, and J. Munro (*Imperial College*).
- The linear analysis of thin-walled space structures, by Dr. H. Tottenham (*Southampton University*).
- The use of analogue computers for structural problems, by Dr. J. P. Jones (*Southampton University*).
- The application of computers to problems involving plasticity, by Dr. R. K. Livesley (*Cambridge University*).
- Matrix analysis of fuselages and the digital computer, by Professor J. H. Argyris (*Imperial College*).

Although a number of different problems were considered in the discussions following the papers, the use of matrix methods in problems of structural analysis formed the central topic of interest. In particular it was noticeable that many of the active computer users attending the conference were concerned with the problems of handling very large matrices, in which the coefficients are grouped about the leading diagonal and the percentage of zero elements is high. The conference closed with a discussion on the application of computers to design problems (as distinct from analysis) opened by D. G. Owen (United Steel Company).

Pegasus Users

Over 86 delegates representing 48 major companies, organisations and universities in Britain and Europe attended the second two-day Pegasus Users' Conference in London on 1 July.

The theme of the conference, which was opened by Mr. B. B. Swann (*Ferranti Ltd.*) was on equipment of the future and the extension of new magnetic tape techniques to computers generally; this is believed to be the first occasion a group have met in Europe to discuss and share their practical experiences in the use of magnetic tape.

Among the range of subjects discussed on the first morning were basic programming techniques for using magnetic tape, and the development of new programming techniques for Pegasus. A review was also made of the recent program acquisitions to the Ferranti program library. In the afternoon, the group looked at developments in faster tape punches, punched cards, line printers and other computer input/output devices.

On the second day, appraisals were made of existing basic programming techniques for clerical data-processing work with examples of such work in progress. Discussions also took place on techniques for production planning and cost analysis.

* * *

Scottish Institute's Computer Course

The Institute of Chartered Accountants of Scotland held its second Computer Course at Troon, Ayrshire, from 14 to 17 October; those taking part numbered 86.

The principal papers were:

- Introduction to electronic data processing, by T. B. Simpson (*Alexander Stephen & Sons Ltd.*).
- Input, Output and Storage, by P. V. Ellis (*I.C.T.*).
- Programming: program control, system analysis and flow charting, by Dr. S. Gill (*Ferranti Ltd.*), with an example of coding a business problem.
- Advantages of electronic data processing, by H. W. Matthews (*National Cash Register Co. Ltd.*).
- A typical business application, by H. W. Matthews.
- Electronic data processing for the small concern, by T. R. Thompson (*Leo Computers Ltd.*).
- Problems to solve before and after installation of a computer, by D. G. E. Benzie (a practising accountant), J. T. H. Macnair (a practising accountant), J. W. Randall (*Rolls-Royce Ltd.*) and J. H. Spooner (*The United Steel Companies Ltd.*). The same team dealt with electronic data processing problems for the practising accountant.

A visit was arranged to a computer in operation at the IBM factory at Spango Valley, Greenock.

* * *

Advanced Systems Seminar

IBM World Trade arranged a programme of lectures and discussions at its European Education Centre, Blaricum, Holland, from 22 to 25 September.

Professor D. N. Chorafas of the Catholic University of America was Director of Studies and the participants were Professors and Heads of Departments of European Universities and Technical Institutes.

TOWARDS A COMMON PROGRAMMING LANGUAGE (2)

In an earlier number of *The Computer Bulletin* (Vol. 3, No. 1, p. 9) the Scientific Programming Committee of the British Computer Society put forward a few suggestions for conventions in published computing methods.

One of these was to precede part of a program by an instruction of the form

$$x = a(b)c$$

to indicate that it is to be obeyed in turn for $x = a$, $x = a + b$, $x = a + 2b, \ldots x = c$.

It is clearly vital that the extent of the sequence of instructions referred to shall be at once obvious to the reader, and some thought has been given to ways of indicating this. A very natural way is to indent the repeated instructions, as was suggested earlier, for example:

$$\begin{array}{l} x = 0 \\ r = 1(1)n \\ \qquad x = x + a_r^2 \\ x = \sqrt{(x/n)} \end{array}$$

This suffers from the disadvantage that the distinction between levels of indentation is rather easily lost, particularly where long sequences of instructions are concerned which may continue on to a separate page, and where several levels are involved. Errors are likely to occur when the manuscript is typed.

To make the extent of the sequence quite unambiguous we suggest that in addition to indentation the control instruction, $x = a(b)c$, is underlined and the sequence to be repeated is marked out by an L-shaped line running vertically beside it to the left, from the end of the underlining, and ending by underlining the whole or part of the last instruction of the sequence.

The effect of this is illustrated below by a program to triangulate a matrix $[a_{ij}]$ by direct elimination with interchanges. Here the notation has been extended to indicate also the scope of conditional instructions. n is the order of the matrix.

$$\begin{array}{ll} \underline{r = 1\,(1)\,n - 1} & \\ \qquad \underline{s = r + 1\,(1)\,n} & \\ \qquad\qquad k = a_{sr}/a_{rr} & \\ \qquad\qquad \underline{\text{If } |k| \leqslant 1} & \\ \qquad\qquad\qquad \underline{p = r + 1\,(1)\,n} & \text{no interchange} \\ \qquad\qquad\qquad\qquad \underline{a_{sp} = a_{sp} - ka_{rp}} & \\ \qquad\qquad \underline{\text{If } |k| > 1} & \\ \qquad\qquad\qquad k = a_{rr}/a_{sr} & \text{interchange} \\ \qquad\qquad\qquad a_{rr} = a_{sr} & \\ \qquad\qquad\qquad \underline{p = r + 1\,(1)\,n} & \\ \qquad\qquad\qquad\qquad \underline{a_{rp} = a_{sp};\ a_{sp} = a_{rp} - ka_{sp}} & \end{array}$$

A further convention is illustrated here by the line

$$a_{rp} = a_{sp};\ a_{sp} = a_{rp} - ka_{sp}$$

Writing these two instructions on the same line means that they are to be effected simultaneously; a_{rp} is not displaced by a_{sp} until it has been used for the calculation of the new value of a_{sp}. Of course an additional register is needed for this.

We have not, so far, taken into account the fact that certain computing operations are only approximately correct. When we write the mathematical equation

$$x = a + b,$$

we mean that the value of x is the sum of a and b. However, if a computation is carried out by machine to a finite number of figures, the result may be affected by rounding-off errors. The value of x so obtained is not the sum of a and b but is merely an approximation. It is nevertheless convenient to describe the process of computing x by the above equation especially when the information which we wish to convey is not particularly affected by the approximate nature of the calculation.

It will also be convenient on occasions to infer that certain computations are exactly carried out. In other words the logical machine is taken to have an infinite number of working figures. We have already assumed this in our discussion of a notation for a cycle of operations. The instruction

$$x = a(b)c$$

is taken to mean that the sequence of operations following after is obeyed in turn for $x = a$, $x = a + b$, $x = a + 2b, \ldots x = c$. This notation usually implies that $(c - a)/b = n$ an integer. Even although this is true it may not be possible to carry out the repeated addition of b to x and obtain the exact value c. Nevertheless it is clear from the context that we intend the cycle to be carried out $n + 1$ times, for values of x up to and including c.

There are also other cases in defining the extent of a cycle where it is appropriate to use the same notation. For instance, the quantities a, b and c may sometimes

be computed by the programme, in which case $(c - a)/b$ may not be an integer. The following interpretation may then be assigned to the instruction $a(b)c$. We exclude the case $b = 0$.

$$\begin{array}{l} n = 0 \\ \text{If } n \leqslant (c-a)/b \\ \quad x = a + nb \\ \quad y = f(x) \qquad\qquad \text{for example} \\ \quad n = n + 1 \\ \quad \text{Repeat if } n \leqslant (c-a)/b \end{array}$$

The use of this interpretation enables a meaning to be given to the operation for all values of a, b and c. In particular we note that if $(c - a)/b$ is negative the cycle instruction has no effect. Again it may be assumed that the quantities involved are computed exactly.

We may also make use of other mathematical notation with the tacit assumption that there is an element of approximation involved. Thus, for example, $y = \sqrt{x}$, $y = \sum_{r=1}^{n} a_r x^r$, $y = \sin x$, $y = \phi(x)$, $y = \int_a^b f(x)dx$, are allowable forms of instructions. Such "compound" instructions may be taken to stand for a sequence of operations or a subroutine. The degree of approximation may then be made clearer either by marginal notes or additionally by writing out explicitly the instructions of the subroutine.

When several operators are used in one instruction we should be careful to avoid ambiguities. The usual rules of syntax in mathematics should be employed in the writing of algebraic expressions. There are no particular restrictions on the number and form of brackets to be used apart from the requirements of brevity and clarity. The use of the solidus to indicate division is advocated in order to simplify printing, but expressions such as a/bc should be avoided as ambiguous and brackets should be employed as in $a/(bc)$ to resolve this.

Further consideration is being given to a more complete description of the explicit use of subroutines. Meanwhile we would welcome any comments on these and previous proposals. Suggestions and comments should be addressed to the Secretary of the Scientific Programming Committee of the British Computer Society (Dr. S. Gill, c/o Ferranti Ltd., 21 Portland Place, London, W.1).

The Algol Bulletin

In an earlier issue of *The Computer Bulletin* (Vol. 2, No. 5, p. 81) we printed the introductory part of a report describing the proposed international coding language for scientific problems known as ALGOL. Compilers for ALGOL are now being used or planned on a number of European computers and those engaged in this work have started regular collaboration through the medium of circulars known as *ALGOL BULLETINS* (abbreviated *AB*).

In consequence of an agreement reached during the UNESCO conference in Paris in June, the *ALGOL BULLETIN* will from now on act as a general medium for the discussion of all proposals for improvements and other questions concerning ALGOL for workers in the eastern hemisphere. Anyone who is actively interested in this discussion is invited to write to the Editor of the *ALGOL BULLETIN*, Regnecentralen, Gl. Carlsbergvej 2, Copenhagen, Valby, Denmark, and ask to be put on the circulation list. Further information about the *AB* group of computer centres can also be obtained from Mr. M. Woodger, Mathematics Division, National Physical Laboratory, Teddington, Middlesex.

Workers in the western hemisphere should write to the Editor, *Communications ACM*, Carnegie Institute of Technology, Pittsburgh 13, Pennsylvania, U.S.A.

Reliability and Maintenance

A series of discussion meetings will be held on Wednesday 20 and Thursday 21 January 1960, at The Institution of Electrical Engineers, and will deal with

"Managerial and Engineering Aspects of Reliability and Maintenance of Computer Systems."

The programme will be divided, one day being given to discussions on such topics as

(i) Component reliability;
(ii) The influence of engineering design on performance;
(iii) Factors affecting the reliability of peripheral equipment.

These meetings will be organised by the Measurement and Control Section of The Institution of Electrical Engineers with the support of its Council.

The British Computer Society will be responsible for arranging meetings on the other day on such topics as:

(i) Methods for determining the functioning status of a system;
(ii) Recording techniques for determining operating efficiency of a system;
(iii) Programming techniques for protection against transient failures;
(iv) Management and organisation problems.

The whole series is being held under the aegis of Group B of the British Conference on Automation and Computation.

BOOK REVIEWS

Non-linear Problems in Random Theory

By Norbert Wiener, 1958; 128 pages. (Cambridge, Mass.: *The Technology Press;* New York: *John Wiley & Sons, Inc.;* London: *Chapman & Hall Ltd.*, 36s. 0d.)

This book is based on a course of 15 lectures on the theory of random processes given by Professor Wiener at the Massachusetts Institute of Technology in 1958.

The first four chapters outline the mathematical methods needed to deal with random processes. The subsequent lectures deal with the application of the theory to a number of problems.

Professor Wiener devotes a number of lectures to the analysis of a model which he has proposed to explain a certain phenomenon (the alpha-rhythm) occurring in electro-encephalography. This model consists of a system of random non-linear coupled oscillators excited by a random input.

Two topics are dealt with which may be of interest to workers in communication theory and allied fields, namely the analysis and synthesis of non-linear electrical networks, and the coding and decoding of discrete time series.

The course is rounded off by sketches of possible applications of the methods developed earlier to quantum theory and to statistical mechanics.

Although most of the lectures deal with quite concrete problems, the mathematical level is uniformly high; this is a book for the specialist.

A. R. EDMONDS

A Practical Manual on the Monte Carlo Method for Random Walk Problems

By E. D. Cashwell and C. J. Everett, 1959; 153 pages. (London, New York, Paris, and Los Angeles: *Pergamon Press*, 40s. 0d.)

A series of international volumes dealing with computer science is a welcome event, and Pergamon Press are to be congratulated on initiating the series with this book about the Monte Carlo method. This technique has been used extensively on both sides of the Atlantic, mainly for studying problems involving neutron and photon behaviour. It consists of tracking a number of particles, from collision to collision, by sampling from frequency distributions corresponding to physical laws. The aim of the book is to give a practical guide to the growing number of workers who are concerned with such problems.

An introductory chapter on basic principles breaks down the problem into a number of component routines, and subsequent chapters consider each of these in detail. Two final chapters, headed respectively, "Remarks on Computation" and "Statistical Considerations" follow, and the book is rounded off by an appendix which gives a summary of 20 problems which were run on the MANIAC I at Los Alamos.

It is not the aim of this review to assess the many methodological features of Monte Carlo work described in this book, such as random number generation, the method of weighting at collisions, and the ways of biasing particle tracks. These and other matters are subjects of specialist study and the authors wisely do not generalise here, for the optimum techniques vary from application to application. Nevertheless, some attention could well have been given to the difficulties involved in constructing an equilibrium neutron distribution; it is true that the problems considered relate to estimating the fate of particles originating from a given source, rather than to the determination of population build-up or decay rates, but a general description of the Monte Carlo method, which the title suggests, might well be expected to deal with the special problems of "settling down."

The collision laws are admirably described in this book, and the programmer is assisted throughout by a number of flow diagrams and very pertinent instructions. He would have welcomed, however, some guidance as to organisational strategy. How and where should the basic nuclear information be accommodated? What layout of information is recommended?

The advantages of simple table look-up, with a minimum of interpolation, might have been stressed where the machine is such that storage presents no real problems. In the same vein, it might have been worth while investigating whether, in the case of elastic scatter, it might not be preferable to store, for given incident energy ranges, both the energy loss factor and the scattering angle, even though these are mathematically connected. The idea of computing whenever possible, though aesthetically attractive, may well lose out from the point of view of computing speed when the alternative is a simple table look-up.

These matters of principle are open to argument, and are to a great extent dependent on the characteristics of the computer used. Their omission from the text does not in any way prejudice the extremely practical description of the routines themselves (incidentally, a simple sampling procedure for drawing from the distribution $p(x)dx = x \exp(-x)$, which occurs first on p. 77, consists of adding the negative logarithms of two random numbers, ξ_1 and ξ_2 or, better, of forming $-\log \xi_1\xi_2$). The text is admirably free from misprint. The chapter headings and subheadings are clearly laid out in the contents section. The absence of a more detailed index, and the paucity of references, are of no importance in a book whose merits are practical rather than theoretical; the book will repay study by every Monte Carlo programmer.

J. B. PARKER

Electronic Business Machines

Edited by J. H. Leveson, 1959; 272 pages. (London: *Heywood & Company Ltd.*, 45s. 0d.)

This book is based on two series of lectures given at the Dundee Technical College in June and July 1958. It sets out to provide a complete *ab initio* study of electronic computers and their application to business problems.

There are three main sections: Programming for Business Purposes; Business Management and Electronic Data Processing; Computer Equipment and Applications. Unlike other books in the Heywood catalogue, this book is not addressed principally to the technician although engineers on administrative or design work should read it.

The contributors, drawn from both sides of the Atlantic, are all very well known in the computer field and there is scarcely any aspect of the subject which is not touched on in varying degree by one or other. Indeed, the editor is to be congratulated in consolidating so much information into 272 pages.

There are, for example, chapters on such diverse subjects as programming, sorting, flowcharting, selection and training of

personnel, choice of computer for varying sizes and types of business, company organisation, etc., as well as details of equipment in use.

Speaking as a programmer, and without minimising the importance of the other contributions, your reviewer would particularly recommend the three chapters on programming which, in his view, represent the best condensed programming course seen to date.

In a book of this type which sets out to cover so much ground there is bound to be some disagreement as to the relative space merited by each topic. In this connection it is felt that perhaps more space might have been devoted to autocoding, although it is appreciated, that, at the time the lectures were given, some of the major British contributions to this art had yet to be published. The book is liberally referenced should the reader wish to proceed to a more detailed study of any particular subject.

While the book contains little which has not already been said before elsewhere, the consolidation of such diverse information into one volume provides a most useful educational medium for newcomers to the field and for managers, students of professional bodies and others, who require either a broad knowledge of the subject, or a starting point for a more detailed study. The book fills a gap in providing a well balanced first course for the potential business user, and it has an excellent index.

L. G. T. Reynolds

Journal of the Association for Computing Machinery, Vol. 6, *No.* 2

April, 1959; 192 pages. (New York: *Association for Computing Machinery*, $2.50.)

This quarterly Journal will already be familiar to many members of *The British Computer Society*, who can now obtain it at a reduced rate through the Society. It has carried many important papers relating to computers and their applications, particularly in the scientific sphere. The April issue is notable for a group of papers describing the input scheme which has been formulated for the IBM 709, to a specification laid down by a committee of the SHARE organisation. It also contains a paper by P. Hildebrandt and H. Isbitz on a new method of internal sorting which they call "radix exchange," and several papers on numerical analysis.

S. Gill

Symbolic Logic and Intelligent Machines

By Edmund C. Berkeley, 1959; pp. v + 203. (New York: *Reinhold Publishing Corporation.* London: *Chapman & Hall Ltd.*, 52s.)

Edmund C. Berkeley is well known in the computer field. He was the author of one of the first books to be published on this subject—*Giant Brains or Machines that Think*—and, whilst the proponents of "lifemanship" who abound amongst computer designers and engineers have decried this book, nevertheless, for some years, it served as a useful introduction to the art and, even viewing it at a distance of a decade, it still bears comparison with other books which, although equally exceptionable, did not arouse the wrath of the critics. Since his original effort, Berkeley has produced a second book on computers and their applications, and now comes forth with the present work which is really concerned with aspects of symbolic logic. As may be expected from a successful author and from the editor of *Computers and Automation*, the style of writing in the new book is very clear, and it is nice to notice the touch of modesty at the end of the preface where the author says that he expects that there are errors in the book apart from the trivial ones of type-setting, and invites the help of readers in the correction of these if the book is reprinted.

The present reviewer found his first point of disagreement with the author in the preface just mentioned. Berkeley claims that he found Boole's *Laws of Thought* to be a difficult and possibly incomprehensible work. In point of fact, the reviewer and a number of people to whom he has talked on the subject agree that Boole's book is one of the most exciting accounts of symbolic logic which has yet been written, and, if it does not convey the light-hearted levity which, as we shall see later, is a part of Berkeley's new book, the adventures in ideas which it discusses amply make up for this deficiency.

Berkeley's book can really be divided into two parts. The first, consisting of chapters 1 to 6, deals with symbolic logic and its representation by Boolean algebra. The second part of the book seeks to apply the techniques of symbolic logic to some elementary problems of machine design and to the analysis of situations of a quasi-logical type. These analyses lead to a discussion of the fact that the original Boolean concepts did not involve an element of time and show how such an extension can be made in the way which was first pioneered by Shannon.

The introductory chapters on symbolic logic are eminently readable, a statement which cannot be made of some other books and papers on this subject. Berkeley seeks to show how each logical concept and symbolic relationship can be related to practical situations of everyday occurrence for example, on page 15, symbolic analysis of the statement "a man marries the mother of a girl who marries the man's father," which by a simple transformation is shown to lead to the statement that the man is his own grandfather-in-law. Passing from the fundamentals of symbolic logic to Boolean algebra, Berkeley first states the rules of calculation of Boolean algebra, and then, by introducing the Venn-diagram, shows by plausible reasons why these should be true. Although the mathematical purist might quibble at demonstrations of the type which are given, there is no doubt whatever that all practical men and many mathematicians of the not so pure kind will be quite prepared to accept his demonstrations as valid.

The work on Boolean algebra leads naturally to interpretations of Boolean algebra in terms of switching circuits and these in turn are made to show how a simple device could be constructed for the determination of the truth or otherwise of certain propositions. This leads more or less naturally to chapter 7 which really marks the second part of the book and is entitled "Intelligent Machines." In his preface and again at the start of chapter 7 Berkeley attempts a definition of intelligence which he maintains to be: "the ability to learn from experience, to acquire and retain knowledge, and to respond quickly and appropriately to new situations, thus resulting in success in the performance of tasks, . . ." On the basis of the acceptance of this definition it is claimed that intelligent machines do actually exist. The reviewer feels that there is considerable doubt about the existence of intelligent machines, even on the basis of this restricted definition,

but it is still true that some approximation to a machine satisfying these criteria can be set up and Berkeley attempts this task in the ensuing pages. It is perhaps unfair to criticise what are obviously meant to be illustrative examples, but the suggestion that a traffic light is displaying intelligence and that a relay retains knowledge, whilst true in a very general context does not help much in the solution of the general problem of the simulation of intelligence. Nevertheless, an introduction via these simple concepts is likely to be a great help to those who are not expert in the field. It would have been difficult in a book of this sort to discuss in physical detail the way in which a traffic light works, but what might be described as the generalised problem of the hall light and its switching arrangement does receive detailed attention and analysis in the light of Boolean algebra. This well-known problem leads to the more complicated one of "Bruce Campbell's will" and shows how a simple machine can solve the sort of intelligence test problem which is popular around Christmas-time.

Leading to more sophisticated devices there is a chapter on reasoning machines and in particular on the way in which the syllogism can be mechanised. The analysis of this is via a set of Venn-diagrams and this leads to the design of a logical truth-calculator. Again, as elsewhere in the book, amusing examples are given and of the syllogism machine there is the problem of the magazine editor's article. All of this work concludes with a discussion of the question whether or not the machines really reason and here Berkeley has shown a full awareness of the strength and weaknesses of the position which he takes up.

Following the discussion of purely logical machines there is a chapter which deals effectively with the problems of designing an arithmetic unit for a digital calculating machine. The particular unit concerned is an adder in decimal scale. A preliminary version is analysed and shown to be inefficient, and then a revised version is derived, analysed, and shown to be far more economical. The author does not really attempt to produce a logically minimum circuit, and modestly remarks, on page 111, that a smaller number of contacts than the 44 which he needs could "be reduced by considerable further effort on the logical design of the addition table circuits." There are chapters on large computing machines and their organisation. These are well written, but would probably need to be illuminated by reading in some other, more elementary descriptive book before they would be comprehensible to anyone who is not already familiar with digital computing.

Having disposed of these topics, Berkeley returns to the problem of generalising Boolean algebra, and in particular to the inclusion of time. His chapter 13 is a very clear exposition of the way in which time operators can be introduced, and it leads to a more practical set of applications in chapter 14, where problems of signalling, the operation of an oil furnace, a traffic light and finally and surprisingly the "divorce mill with bigamy alarm" are discussed. What the "divorce mill with bigamy alarm" is we leave to the delectation of readers of the book to find out. This section concludes with a description of a robot animal, the artificial squirrel "Squee," which was described in 1950–1951 by Berkeley. The way in which logic has been used to produce involved circuits for this device will be of interest to anyone who has ever considered the construction of automata.

The book ends with a chapter on symbolic logic and the programming of automatic computers. This appeared to be the least satisfactory part of the book. It is too short to be comprehended by anyone not already familiar with programming and therefore, probably, with the ideas of symbolic logic; and if the latter class of reader is intended, it is insufficiently penetrating to justify the effort of reading it. It is particularly surprising to find such a book including a programme for the extraction of a square root by the usual iterative process. There is a useful bibliography of works in the field, and a comprehensive index. It may appear that some of the remarks made above are exceedingly critical. This, however, is only in the spirit suggested by Berkeley in his preface. The book can be thoroughly recommended for its refreshing style: its blemishes, whilst perhaps objectionable to the purist, are nevertheless ones which can easily be removed in any subsequent edition. It is probably the first book to be published since Boole which is sufficiently amusing to hold the attention of non-specialist readers. Several other books on the same subject have appeared during the past year or so, but none of these make the slightest appeal to the non-specialist.

A. D. Booth

BOOKS RECEIVED FOR REVIEW

Canadian Conference for Computing and Data Processing (Toronto, June 1958)

1959; 383 pages. (Toronto: *University Press*, \$5.00; London: *Oxford University Press*, 40s. 0d.)

Use of Electronic Data-Processing Equipment (Hearing before U.S. Congress Sub-Committee, June 1959)

1959; 142 pages. (Washington: *U.S. Government Printing Office*)

Design of Transistorized Circuits for Digital Computers

By A. I. Pressman, 1959; 316 pages. (New York: *John F. Rider Inc.*, \$9.95); London: *Chapman & Hall Ltd.*, 80s. 0d.)

Digital Computer Primer

By E. M. McCormick, 1959; 214 pages. (London: *McGraw-Hill*, 58s. 0d.)

Programming Business Computers

By D. D. McCracken, H. Weiss, and T. H. Lee, 1959; 510 pages. (New York: *John Wiley & Sons Inc.;* London: *Chapman & Hall Ltd.*, 82s. 0d.)

Mathematical Programming and Electrical Networks

By J. B. Dennis, 1959; 186 pages. (New York: *Technology Press of Massachusetts Institute of Technology* and *John Wiley & Sons Inc.;* London: *Chapman & Hall Ltd.*, 36s. 0d.)

THE IBM 1401 DATA PROCESSING SYSTEM

by J. P. Hough

Introduction

This article describes a new data processing system with the following features:

Processing at microsecond speeds.
Card reading up to 800 cards a minute.
Card punching at up to 250 cards a minute.
Line printing at up to 600 lines a minute.
Tape passing speeds of up to 62,500 characters a second.

The article is divided into two parts:

(1) A general description of the system.
(2) Some details of 1401 logic and programming.

1. General Description

The IBM 1401 Data Processing System has been designed to meet three requirements:

(1) To provide a punched-card data processing system for those organisations whose requirements are not fully met by existing punched-card equipment, although these organisations cannot fully utilise a medium or large scale computing system. A 1401 system is now available to meet this need and rents from £972 a month (purchase price from £49,350).

(2) To provide a more efficient, more economical method of off-line processing of data stored on magnetic tape; for instance, data conversion from card-to-tape, tape-to-card, and tape-to-printer; in addition, the processing unit of the 1401 enables it to carry out tape editing, searching, merging or sorting on an off-line basis, thereby releasing more expensive systems for tasks more appropriate to their greater power and processing speed. A 1401 tape-to-printer system with one tape unit is available from £1,532 a month (purchase price from £64,000) and a card-to-tape, tape-to-printer, tape-to-card system with two tape units is available from £2,033 a month (purchase price from £85,000).

(3) To provide a medium-sized magnetic tape data processing system which is particularly suitable for performing large-scale file maintenance procedures speedily and economically. Such a system is available with two tape units from £2,033 a month (purchase price from £85,000).

The basic 1401 system comprises three units.

1401 Processing Unit

The 1401 Processing Unit contains the logic, arithmetic and control circuitry for the entire system, together with the magnetic core memory with a capacity of 1,400, 2,000 or 4,000 alphanumeric positions. Each position is individually addressable and able to store any one of the 10 numeric, 26 alphabetic and 12 special characters. Data and instructions can be stored in the system in words of varying length and the system is basically a two-address, add to storage, type of system (where A (AAA) (BBB) means add what is in AAA to what is in BBB and store the result in BBB).

Instructions are normally stored in sequential locations in storage and executed in that order unless a transfer instruction is given. The combination of single position alphanumeric representation, variable word length and a powerful instruction code is estimated to give an increase in the usefulness of the storage provided of up to three times over a fixed word length system with two position alphanumeric representation. 1401 data transfer is parallel by bit, serial by character and the character cycle time is 12 microseconds. All data transfers are automatically checked by the use of a self-checking odd-bit parity check code. Typical operation times are as follows:

Addition	8 positions + 8 positions	0·310	ms.
Multiplication	6 positions × 4 positions—programmed	15·0	ms.
	or by optional built-in circuits	2·4	ms.
Comparison	6 position: 6 position	0·240	ms.

Automatic sterling operation is provided. (An add-to-storage and variable word length system implies that the factors in arithmetic operations may be of any length.)

1402 Card Read Punch

The 1402 Card Read Punch operates at up to 800 cards per minute in the read feed and up to 250 cards per minute in the punch feed. The cards in the read feed are read twice, and an automatic comparison and check is made before any processing begins, the data read from the card being stored in positions 001–080. Cards in the punch feed are punched from storage positions 101–180 and the punching is then read back, compared and checked with information still in storage. The read feed of the 1402 is fitted with a file feed unit with a capacity of 3,000 cards, the punch feed and each of the five stackers can hold 1,000 cards, and the stackers are of the radial, non-stop unloading type. Selection of which stacker a card falls into is under program control, making possible the automatic selection of master and detail input cards and of standard and exception output cards while processing is being carried out.

1403 Printer

The 1403 Printer operates at up to 600 lines per minute, a line being of either 100 or 132 characters. This speed is achieved by a printer of a new kind where a continuous chain feeds past the printing bank at a constant speed of 90 inches per second. This chain has engraved upon it five complete repertories of 48 numeric, alphabetic and special characters. During each print cycle, each character is read out of each storage position 49 times, and one complete segment of 48 characters passes the print bank; in this way it is possible to print any character from any position once in each cycle and check every position on the 49th sub-cycle of each print cycle. Data is printed exactly as it is laid out in storage positions 201 to 300 (or 332).

Form feeding is under program control and, to provide form feeding speeds commensurate with the speed of printing, a dual speed carriage is available which feeds forms from one printing line to the next at 33 inches per second where the movement is 8 lines or less, and at 75 inches per second thereafter, the higher rate of skipping giving speeds up to 36,000 lines per minute.

The printer and its form stand have been specially designed to facilitate the rapid handling of the large volume of paper likely to be produced.

1401 Tape Systems

To the basic systems already described may be added up to six IBM 729 Magnetic Tape Units.

The 729 Magnetic Tape Units are available in two models:

The Model II moves tape at 75 inches per second, and
The Model IV moves tape at 112·5 inches per second.

Data may be written on tape by either model in one of two densities, 200 characters to the inch or 556 characters to the inch, thus giving a choice of four speeds of tape passing: 15,000; 22,500; 41,667 and 62,500 characters per second. Complete inter-system communication is available between the 1401 and other IBM tape systems. Tape records may be of variable length.

Both models of the 729 Magnetic Tape Unit incorporate a two-gap head consisting of a write head followed by a read head so that data written on tape is immediately read back and checked against the source data. Tape may be read or written in a forward direction only.

General

The system is completely transistorised with consequent advantages in reduced size, heat dissipation and power consumption, and in increased reliability. Thus a card system weighs between 3,000 and 4,000 lbs.; can be installed in a room 300 square feet in area and $7\frac{1}{2}$ feet high; dissipates about 20,000 B.T.U.'s per hour and consumes about 8 KVA. The permissible operating conditions for a card system are:

Temperature	50–90 F.
Humidity	20–80%

The basic system is not buffered and processing is limited during input/output operations. Where the facilities for overlapping input, output and processing are not sufficient, optional features are available to extend these.

Thus in an unbuffered card listing operation involving reading a card, then printing a line, the overall speed of the system is reduced to a maximum of 400 cards/lines per minute, whereas a buffered system gives a maximum of 600 cards/lines per minute for the same operation.

All format is program controlled in the 1401 and no control panels are necessary. The 1401 has a powerful *EDIT* instruction which is described in the second part of this article.

2. Some Details of 1401 Logic and Programming

The Word

In order to maximise utilisation of storage space both data words and instruction words may be of variable length. Since a word is of variable length, there must be some means of defining what constitutes a word and this is achieved by requiring that each word should have a word mark in its senior position. This word mark is, in fact, a bit in a special eighth channel in the 1401 character structure (CBA8421W). The structure of the eight bit character is C = check bit, BA = alpha zones, 8421 = numeric bits and W = word mark.

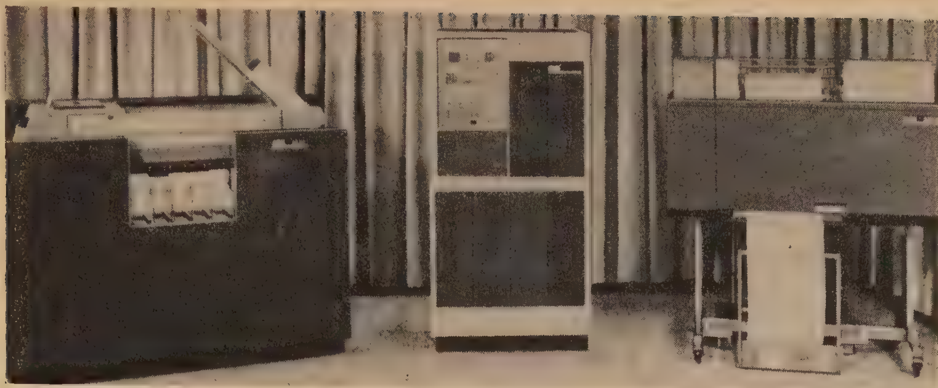
The Group (*or Record*)

Similarly a variable length group is indicated by a special Group Mark and this is set as an additional character position at the junior end of a group, adjacent to it and not part of it.

Addressing

An instruction word is addressed in its high order position and scanned from left to right. A data word is addressed in its low order position and scanned from right to left.

In order to conserve storage space any of the 4,000 possible locations is addressable by a three digit address. This is achieved by considering the memory to be divided into 40 bands of 100 positions. The position within the band is specified by the digits 00–99 in the junior positions. The bands are identified by 40 of the 48 standard IBM characters in the senior position.



The Form of an Instruction

An instruction will take all or part of the form 0 (AAA) (BBB) d, where:

0 is the Operation Code,
AAA is the address of the low order position of the A field,
BBB is the address of the low order position of the B field,
and d is the digit modifier.

However, the form of the instruction may vary from instruction to instruction and all the following forms may be valid:

0	0 (AAA) d
0.d	0 (AAA) (BBB)
0 (AAA)	0 (AAA) (BBB) d

Instruction Execution Times

This being a serial-by-character machine, instruction execution times are governed by the length of the instruction and of the A and B fields. Use of variable word lengths for both instruction and data words thereby significantly reduces instruction execution times.

The 1401 *Instruction Code*

INPUT/OUTPUT

The 1401 has the usual range of input/output instructions together with single instructions for multiple input/output operations (such as Read and Print, Read and Punch, etc.) and special instructions governing form feeding and card stacking.

DATA MOVEMENT

The 1401 data movement instructions are extended to provide for the field size of an operation being controlled by either the A or the B word mark as may be necessary. The normal mode of operations is for word marks to be pre-set in an initialisation procedure and for the A field to adopt the size of B field.

ARITHMETIC

The arithmetic instructions are of the standard two-address type previously described.

BRANCHING

The 1401 normally takes its next instruction from the next consecutive location but this may be modified in a number of ways:

(1) Where a valid instruction takes the single character form 0, 0 (AAA) will usually mean perform 0 and then go to (AAA) for the next instruction.

(2) T (AAA): unconditional transfer to AAA.

(3) T (AAA) d: transfer to AAA if the test designated by d is satisfied. (This instruction caters for such conditions as arithmetic overflow, end of file condition in the card read feed, and an unequal condition as a result of the last preceding COMPARE instruction.)

(4) T (AAA) (BBB) d: if the character in location BBB is exactly the same as that in the d position of the instruction, go to AAA.

(5) Z (AAA) (BBB) d: branch to AAA on signs, overflow indications and word marks in BBB.

EDIT INSTRUCTION

This instruction takes the data in A, edits it in the manner required for output or further processing and places the edited result in B. This editing is done by means of an edit control word which is placed in the B field prior to the execution of the EDIT instruction. The effect of this is to take the characters in A and place them in B in the same sequence but not necessarily at the same intervals, inserting constant data where necessary, suppressing insignificant zeros and commas and printing CR (or —) when the field is negative.

CHAINABILITY

Upon the completion of most of the data movement and arithmetic instructions and also of certain other instructions, the memory address registers will contain the addresses of the low order positions of the words adjacent to and to the left of the A and B words just operated on. These positions are the addresses of the words adjacent to, and to the left of, the A and B fields just operated on. If the original instruction had been written in the form 0 (AAA) (BBB) (0) (0) (0), then a series of instructions would be executed. It should be noted that the operations performed need not be the same and that only in certain circumstances do the pair of A and B fields need to be of equal length. In this way, both storage space used and instruction execution time are reduced; for instance, four chained MOVE instructions reduce storage space required for the instructions from 28 position to 10 positions and execution time for 960 microseconds to 744 microseconds.

FERRANTI'S ORION SYSTEM

Ferranti Limited have announced a new commercial data processing system to be known as the ORION system, which uses the Neuron logical elements first developed for the SIRIUS computer. When SIRIUS was described in *The Computer Bulletin* (Vol. 3, No. 2) it was forecast that the next step would be a large data processing system.

Full Range of Equipment

The ORION is fully transistorised with an extendable magnetic core store, magnetic drum backing store. It can accept and produce data in the form of magnetic tape, punched cards and paper tape, and has a very fast line-at-a-time printer. The interesting techniques available with the ORION system include automatic time sharing and priority processing, and optional floating point arithmetic.

Time-Sharing

Ferranti have designed the ORION system to make the fullest use of the hardware at all times by storing several programs at once. When one program is waiting for an input/output device the computer will use the time to process another program, and will return to the appropriate program when the input/output unit is ready. There are built-in facilities to carry out this procedure and to ensure that programs do not over-write each other in the main store or use the same data space.

The needs of the programmer seem to have been well borne in mind. A special routine decides the priority of the programs usually in the order of the slowest devices first, and many selections of programs may take place every second. Programmers will be pleased to know that the priority processing is fully automatic and the programmer does not have to concern himself with these matters when writing his program.

Words and Data Transfers

A word in ORION can contain

(*a*) 14 decimal digits or 48 binary digits;

(*b*) 8 alphanumeric characters;

(*c*) One three-address instruction or one modified two-address instruction;

(*d*) A floating point number with the precision of 11 significant decimal digits.

No buffers are required as data is transferred directly between any peripheral device and the computer locations, yet the computer can be performing other work once the transfer has started.

Specification

ORION includes the following equipment

(*a*) A magnetic core store from 1,024 to 4,096 words;

(*b*) A drum unit normally consisting of two drums of 16,384 words each—the average access time is 12 milliseconds;

(*c*) A fast card reader and punch;

(*d*) Four AMPEX FR.300 magnetic tape units—much faster than magnetic tape equipment on previous *Ferranti* machines;

(*e*) *Rank* XERONIC printer (3,000 lines per minute);

(*f*) Paper tape readers at 1,000 and 300 characters per second;

(*g*) CREED paper tape punches at 33 and 300 characters per second.

Speeds

ORION is much faster than the previous commercial machines of *Ferranti Ltd.*, with a basic pulse rate of $\frac{1}{2}$ megacycle and semi-parallel arithmetic. A three address addition ($A + B$ to C) requires 64 microseconds, and a modified two address addition ($A + B_m$ to B_m) requires 68 microseconds. Multiplication takes from 64 to 200 microseconds and division from 100 to 900 microseconds. The first 255 words in the core store can act as modifiers or index registers.

Magnetic tape processing is at the rate of 89 microseconds per word plus approximately 10 milliseconds stop/start time for each inter-section gap. Tape sections can be of variable length and normally there will be several items per section. A section of 250 words might contain 25 items of 10 words each, and such sections can be read or written at the rate of 1,800 sections per minute. *Ferranti* state that this corresponds to a card reading speed of 45,000 80 column cards per minute. The magnetic tape rate is 90 K/c.

An automatic interrupt facility is provided for all input/output equipment, including drums. To take magnetic tape as an example, a word of 8 characters is transferred to or from core store in approximately 16 microseconds, interrupting the main program every 89 microseconds.

ORION is a binary machine and special orders are available for the fast conversion to and from other radices such as decimal and sterling.

Price

The price of the ORION system varies with the amount of peripheral equipment; but a typical installation could be between £100,000 and £150,000. A system can be added to, once installed, as the needs of the organisation grow.

KDP.10 DATA PROCESSING SYSTEM

The *English Electric Co. Ltd.* are now marketing in the United Kingdom a new data processing system, KDP.10, which is based on the *Radio Corporation of America's* 501. It is a transistorised magnetic core system which is already installed, proven and working in the United States. *English Electric* have set up a new Data Processing and Control Systems Division and are building the computer and peripheral equipment at their Kidsgrove works. The components will be anglicised and modified to suit manufacturing and operational requirements in the United Kingdom.

Magnetic Tape Operations

Great attention is paid to the use of magnetic tape in the data processing system. Tape reading and writing is at the rate of 33 Kc—33,333 characters per second—and tape records can be of any variable length. The gap between records on magnetic tape is very low—only a third of an inch—thus making high use of the space on the tape.

The magnetic tape can be read in both directions thus saving on rewinds, but written in one direction. There are 16 channels on the tape, consisting of two sets of eight channels, and each character is recorded in both sets (i.e. in duplicate) to give safety against small imperfections on the tape. Either one of the two recorded spots for a single bit may be missing and yet the bit, and hence the character it is part of, can be read.

Tape transfers are in units of four characters to or from the appropriate positions in the core store, by means of an automatic interrupt facility. The transfer takes 15 microseconds and interrupts the main program once every 120 microseconds.

Quick loading and unloading of reels is helped by the use of permanently threaded leaders.

Up to 62 magnetic tape units of RCA design can be used, and the minimum will probably be 4 tape units.

Magnetic Core Storage and Data Representation

The random access magnetic core store is available in steps of 16,384 character locations up to a maximum of 262,144 characters. Words and word times are not significant since the KDP.10 has the ability to handle one character or four characters in parallel, and can transfer them to the memory register during one 15 microsecond cycle. Data is stored not in binary but as seven bit alpha-numeric characters with a range of 64 characters.

All arithmetic calculations are performed simultaneously by the hardware in two separate ways and the results automatically compared.

Instruction Code

The KDP.10 uses an eight character two address instruction code. The first character specifies the function, the following three characters denote the first address, the next character is used for modification of the first and second address, and the last three characters specify the second address.

Peripheral Equipment

There is a large range of peripheral equipment, all of which may be manufactured by *English Electric*, including:

(*a*) On-line 600 line-a-minute high speed printer;

(*b*) Monitor printer similar to an electric typewriter operating at 10 characters per second;

(*c*) Off-line punched card to magnetic tape converter at 400 cards per minute;

(*d*) Off-line magnetic tape to punched card computer at 150 cards per minute;

(*e*) Paper tape reader at 1,000 characters per second.

Adaptability

English Electric state that subsequent increases to an installation can readily be made by the addition of core store, tape units or peripheral equipment without change to the basic system and with a short downtime.

Price

The KDP.10 system can vary in size but the price is stated to be from £200,000 upwards. Delivery is set for the middle of 1961.

NEWS FROM MANUFACTURERS

Orders for Emidec Computers

E.M.I. Electronics Ltd. have announced sales of five more computer systems. The all-transistor EMIDEC 1100 has now been ordered by *Barclays Bank Ltd.* (£125,000), *Air Ministry* (£190,000), *Ministry of Labour and National Service* (£140,000) and *Kodak Ltd.* to bring the total number of orders to ten; in addition the *Royal Army Ordnance Corps* have ordered the large EMIDEC 2400 data processing system. The machines are scheduled to be delivered in 1960 and 1961.

The processing to be performed covers a wide range, including invoicing and customer accounts for Kodak, centralised booking in a group of London branches for Barclays, payroll for the two Ministries, labour and price statistics for the Ministry of Labour and inventory control for the RAOC.

The Barclays application is especially interesting because information will be transmitted from the branches by teleprinter without moving any documents to the computer installation.

* * *

Two uses of Xerographic Printers

Ferranti Ltd. have ordered the first *Rank* XERONIC printer for use with one of its future computers. The machine will print up to 3,000 lines a minute and will simultaneously print one of four different form outlines, the correct form being selected by signals from the computer. Delivery is expected in November 1960.

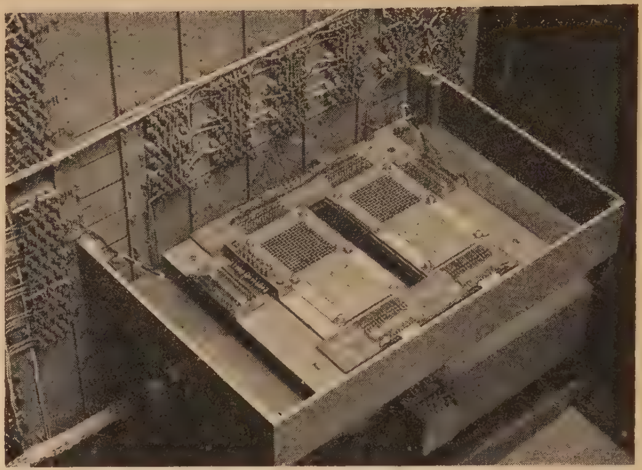
The *Patent Office* have installed a £17,500 *Rank–Xerox* COPYFLO machine to copy on request patent specifications which have gone out of print. The file copy of the specification will be microfilmed and the microfilm will be used on the COPYFLO to enlarge the pages to their original size on plain, unsensitised paper. It is stated that the microfilm, which is very cheap, will be used merely as a throwaway intermediate step. It is expected that about 2 million pages a year will be copied.

* * *

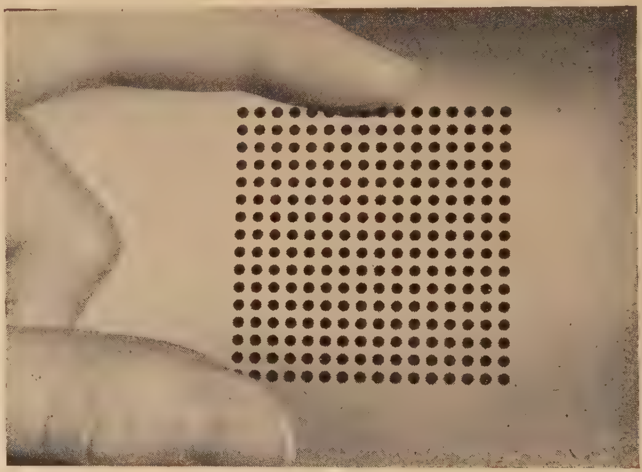
Internal Magnetic Film Memory

Experiments have been proceeding to develop a high speed magnetic film memory—not to be confused with the ELLIOTT 35 mm magnetic film external storage units—which may eventually take the place of magnetic cores. The film memory has several potential advantages over magnetic cores—it has a faster cycle time, lower power dissipation, greater compactness and is easier to manufacture.

The Lincoln Laboratory of the Massachusetts Institute of Technology are now operating a high speed magnetic film memory as part of the TX–2 digital computer. It is an experimental prototype for larger units and has a capacity of 32 ten-bit words. The read and write cycle time of 0·8 microseconds is consistent with the speed of the computer itself, although bench tests have demonstrated successful operation at a cycle time of 0·4 microseconds. The net driving current for writing is 150 milliamperes, and one-millivolt output signals are obtained from the individual memory elements.



First operating magnetic-film computer memory at MIT Lincoln Laboratory in Lexington, Massachusetts



Experimental magnetic film memory array of the type installed in the TX-2 computer at MIT Lincoln Laboratory

Each memory element is a circular spot of PERMALLOY film, 1·6 millimeters in diameter, centred 2·5 millimeters apart. The spots are deposited by evaporation on a flat glass substrate, 0·1 millimeter thick, in 16 × 16 unit arrays. The photographs show the size of one array and the complete memory unit as installed in TX–2.

MIT say that the memory has confirmed expectations but none of its properties has been fully exploited in this first development model.

* * *

New Elliott Computer

Elliott Brothers (London) Ltd. have produced a new small but powerful digital computer called the 803, which is similar to the 802. The 803 has a magnetic core store of 4,906 words switched by transistors and mounted on printed circuit boards. Any store location may be used as a B-line modifier.

The basic cycle time is 720 micro-words during which addition can be performed, but multiplication and division take longer. All the logical and storage units are contained in a single cabinet. Input and output is by paper tape at present, but an adaptation of the magnetic film storage used on the 405 is under development.

The first 803 has been sent to America, where it will form part of the 609 process control system produced by Elliott's associates, *Information Systems Incorporated*, a subsidiary of *Panellit Incorporated*. The 609 system will be installed at the *Gulf States Power Company's* Nelson Station in Louisiana. A further seven 803 computers are also due for export to U.S.A.

Panellit Inc. were developing their own computer for use in their 609 process control system but, when they saw the Elliott machine, they were convinced it was so much better that they stopped their own development and arranged exclusive rights to market the 803 in the U.S.A.

* * *

Appointments

I.B.M. (U.K.) Ltd. announce that Mr. D. J. N. Stirton has been appointed Sales Manager of the Data Processing Division. He joined the company in 1952 as a Data Processing Salesman and became Manager of the I.B.M. office in Birmingham in 1954.

The Data Recording Instrument Co. Ltd.—an associate company of *I.C.T. Ltd.*—have appointed Mr. C. G. Hutchinson as General Sales Manager. The company specialise in high quality magnetic tape recording devices and the development of magnetic tape decks.

* * *

New IBM Sorter

IBM now have a new alpha-numeric sorter, the 084, which can sort cards at the rate of 2,000 a minute. Photo-electric sensing replaces the standard sensing brush, a beam passing through a punched hole to set up a transistor circuit which guides the card into its correct stack.

* * *

Gas Board Instal PCC

The *South-Western Gas Board* centralised some time ago their mechanised accounting in Bath, and have now taken delivery of two ICT Programme Controlled Computers (PCC) and two SAMASTRONIC Tabulators. Another two SAMASTRONIC tabulators will be delivered in the future to complete a system capable of dealing with all the accounting and costing activities of the Board. The whole punched card and computer installation is operated by about 80 female staff.

* * *

Ferranti Machine Tool System

Ferranti Ltd. have developed two new machine tool control systems which they claim are economical for the small and the large engineering company. The systems are called, Transistor Hydraulic Continuous, and Numerical Positional. The continuous system operates from normal electricity mains, thus avoiding the use of frequency converters, and is fully transistorised. The maximum length of machining time has been increased by four times over the old Ferranti system. The price ranges from £7,000 to £12,000, which is a reduction of at least 25 per cent.

The numerical positional system is an entirely new equipment which does not require the use of a computer, as information is presented to the control console by paper tape which can be prepared by the machine tool operator. It is designed for point-to-point positioning of machine tools in Cartesian or polar co-ordinates. The price is between £2,000 and £3,000.

* * *

Seat Reservation System

Trans-Canada Air Lines have ordered a fully transistorised computer system, for use in their seat reservation system, from *Ferranti-Packard Electric Ltd.*, Toronto, the Canadian subsidiary of *Ferranti Ltd.* Earlier this year *Ferranti-Packard Ltd.* were given the order for booking office and communications equipment including the transactor.

The computer system due in 1961 is to consist of two identical machines both capable of using a common set of magnetic tapes and input/output equipment. The new order worth about $1,500,000 was obtained in face of severe competition from companies in the U.S.A. and Canada.

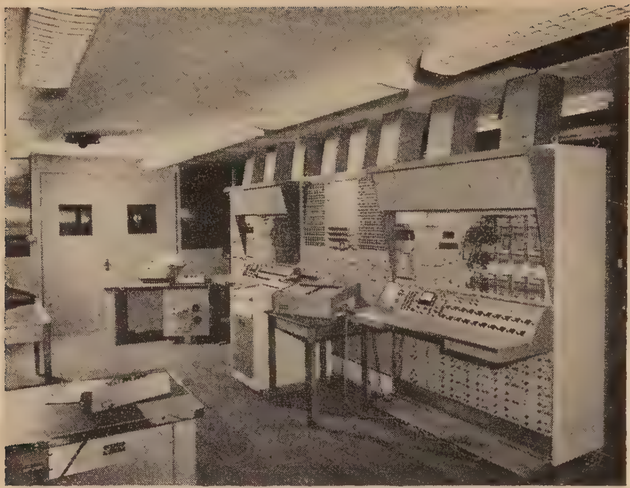
* * *

Honeywell Magnetic Tape Units

In America, *Honeywell Corporation* are developing a magnetic tape unit which uses air pressures and vacuums to guide the movement of the tape instead of the normal mechanical brakes and clutches. It is claimed that this will remove tape damage, caused by internally created dust particles, by eliminating all metal contact with the data-bearing side of the tapes.

* * *

The Editors of
The Computer Bulletin
offer their readers
The Season's Greetings



PACE *Analogue Computing System installed by the Atomic Energy Authority at their new Research Establishment at Winfrith Heath*

Analogue Computers

The first PACE analogue computing system in the U.K. has been installed by the Research Group of the *Atomic Energy Authority* at Winfrith Heath, at a price of about £100,000. It contains two separate 80 amplifiers which can operate separately or together.

Thirty-five PACE computing systems have been sold in Europe since July 1957 by *Electronic Associates Incorporated*, ranging in size from the basic 20-amplifier to 200-amplifier. Five other PACE Computers have been sold in the U.K.—to the *UKAEA* at Risley, the *AEI* (*John Thompson Group*), the *Armament Design Centre* at Fort Halstead, the *Central Electricity Generating Board* and the *Ministry of Supply* at Fort Halstead.

* * *

The Solartron Electronic Group Ltd. have introduced a new analogue computer called SPACE 30. It is the first computer of its type to be made commercially available in desk console form. It owes its name to the fact that is has 30 operational amplifiers. The price is £10,500.

* * *

Short Brothers and Harland Ltd. are introducing a large multi-unit analogue computer. The basic instrument is an 112-amplifier linear computer but it can be adapted to customer's requirements by plugging the specified components into the standard racks. The computer is claimed to be new in design, wiring technique and ease of operation, and production models are planned for 1960.

* * *

Inauguration of the first Ferranti Perseus system on 29 *October in Stockholm: Mr. Sebastian de Ferranti (left) and Mr. Carl Erik Schang watch the first operations. Mr. Schang described at the Business Computer Symposium in December* 1958 *how Datacentralen, of which he is managing director, intended to use the machine for the work of the Trygg and Fylgia insurance companies*

Editorial

THE IMMEDIATE FUTURE

Some industrialists are still said to be in the process of discovering that computers cannot think. Yet the computer manufacturers have always stressed the importance of completing the fundamental thinking *before* the installation of a computer. They themselves have publicised the wry story of the firm that so improved its methods during the systems study stage that a computer proved unnecessary.

Is 1960 to be a year of major developments in business computers and one of sound consolidation for scientific computers? The rank and file of industry are becoming increasingly aware of the need to be reasonably well-informed on computers and this *Bulletin* gives details of some of the courses that were offered in the past year, additional to those run by the computer manufacturers.

At one of the educational peaks there is now established a Chair of Computer Engineering. One is tempted to ask if the art of programming has any claim to academic status. In the meantime programmers and supervising engineers urgently need some nationally recognised qualifications. Can the Society co-operate with an Examining Body such as the City and Guilds to create these?

COMPUTER COMMENT

Professorial Chair

We warmly congratulate Dr. T. Kilburn, a member of our Editorial Board, on his appointment to the Chair of Computer Engineering at Manchester.

Dr. T. Kilburn, who is 38 years old, was born at Dewsbury, Yorkshire, and was educated at Wheelwright Grammar School. He read mathematics at Cambridge, and in 1942 went to the *MOS* Radar Research Establishment at Malvern. In 1947 he was seconded to Manchester University to do research in the Electrical Engineering Department. In 1948 he became a lecturer on the staff of the Computing Machine Laboratory at Manchester University, and by 1955 was appointed reader to that department. He holds the M.A. degree at Cambridge and both the Ph.D. and D.Sc. from Manchester. In addition he has received several awards from the *IEE*.

He is married with two children, and admits to having stamp collecting and gardening as his hobbies.

* * *

Discarded Glossary Items

Marginal Testing: Testing whose value is dubious.

Preventive Maintenance: Maintenance undertaken to prevent the use of the computer.

Half-Adder: Adder used to add $\frac{1}{2}$ in the first binary place to be dropped.

* * *

Alphabetic Coding

SID: Sudden Ionosphenic Disturbance (*Electronics*, 23 October 1959, p. 97).

DAFT: Digital Analog Function Table (*Packard-Bell Corporation* Sales Literature).

Central Technical Services, Risley

A visit to the Computer Section, *UKAEA* Risley, was arranged for the Press on 25 January 1960. The installation, described as the largest general purpose computing centre in Europe, consists of the Ferranti MERCURY and *IBM* 704 digital computers together with an *EAI* PACE analogue computer. These comprehensive computing facilities are necessary for the problems and calculations that can arise in the development of new reactor systems and nuclear processing plant.

The *IBM* 704 operates in a special air-conditioned room and the layout of the computer rooms and ancilliary equipment has been carefully planned. Overall efficiency of the machines is high, 95–96% being quoted. An automatic data transmission link between Risley and *AERE* Harwell and Winfrith Heath enables each research group to make full use of the *IBM* 704 in its work.

The staff includes 28 programmers who specifically prepare the problems for presentation to the machines. The use of automatic programming codes by the staff is approximately 20%.

* * *

ZEBRA in Aldwych

Standard Telephones and Cables Ltd. have installed a STANTEC-ZEBRA computer at their headquarters in Aldwych.

More STANTEC-ZEBRA's have been exported abroad than any other British-made computer. They are in service in Australia, Belgium, Canada, Denmark, Germany, Holland, Portugal, South Africa and Switzerland.

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THE U.C.T. IN EUROPE

by J. L. England

A visit to Hamburg and Zürich in September 1959 was arranged for me by the London Office of *Remington Rand Ltd.* with the object of seeing actual applications on the *Remington Rand UCT* Computer.

The *UCT* Computer is also known as the "UNIVAC 90" and in this country has been described as "UNIVAC 80." This depends upon the punched card system used, i.e. normal 80 columns or *Remington's* 90 columns. It is of new design using transistors, magnetic cores and Ferractors. The last named is a pulse-amplifying device using magnetic core techniques. The units comprising the "UNIVAC" are:

Central Processor		
High-speed card reader	450 cards p.m.	
Read-punch unit	150 cards p.m.	
High-speed printer	600 lines p.m.	
The internal speeds are:		
Word time	17 micro-secs	
Addition	85 micro-secs	Not including access time
Multiplication	102–1,790 micro-secs	
Division	425–1,960 micro-secs	

Main store is a 5,000 word drum with an average access time of 3·4 millisecs, and 1,000 of these 5,000 comprise the fast store by means of extra read/write heads, reducing the average access time to 850 microsecs. Data and instructions are obeyed from the drum as there is no core fast store. There are three registers for arithmetic operations and one register to hold the instruction currently being obeyed.

The input on the installations seen was by Remington Rand 90-column cards. The 90-column, although used extensively on the Continent, is not used in the U.K. It consists of a double row of 45 columns using coded decimals with complete alpha characters, e.g. 1 is punched as 1, but 2 is a combination of 1 and 9. There are no plugboards as all editing and format control is performed by program.

None of the installations seen were equipped with magnetic tape units, but these will be available.

The price F.O.B. from American factory is £124,000 and it is stated that the British price will be based on this, having regard to import duties. The estimated cost of installations seen if installed in Britain will probably be around £140,000.

Programming would not appear to be unduly difficult and uses the 1 + 1 address system. The automatic programming techniques are in actual operation, and there is a "plain language" programming known as

"Flowmatic" available. It is claimed that a novice can program the computer using "Flowmatic" within two weeks.

It is interesting to note that there are already ten *Remington UCT* computer installations in Switzerland and twelve in Germany.

During the visit three installations were seen, one of which was the *Remington Rand* Service Bureau at Zürich. This Centre provides "Customer Service" for waiting purchasers to develop their programs, and also for hiring computer time. The others visited were the *GEG* (Co-operative Wholesale Society) and *Hug & Co.* (Shoemakers).

The popularity of the *UCT* is due to the fact that it is relatively of low cost and has advanced circuit design. It is faster than the card computers at present in use in this country and being a solid state computer requires less maintenance.

Hug & Co., Shoemakers

Hug & Co. AG. has its head office at Herzogbuchsee, near Berne, and manufactures high-quality shoes. Founded in 1878, it is now the second largest footwear manufacturer in Switzerland. In three factories over one million pairs of shoes are manufactured annually, which are sold in their 41 retail shops spread throughout Switzerland, as well as in other retail organisations.

In 1956 the Management decided to instal a *Remington Rand UCT* system because the conventional punched card system could not keep up with current requirements. This meant a change from 80-column to *Remington* 90-column system.

Important among the requirements was a system of planning and production control, and from this is developing an integrated system which will be one of the few complete ones in use anywhere.

During our visit, we were only able to see two parts of the system in operation and it would have been interesting to have spent a few days at the Centre to have seen further applications. So far 70 programs have been written in 1 year by an average number of 4½ programmers drawn from own staff and *Remington Rand*; 70 more programs are now in course of preparation.

The computer operates on a 9-hour daily shift basis with 1 hour per day preventive maintenance. The average down time amounts to 2% of productive time, i.e. 2% of 9 hours per day, and this has usually been due to mechanical, rather than electronic, failures.

The operations so far carried out are:

1. Production planning and control.
2. Raw material control.
   Machine spare part control.
3. Wages of operatives.
   Salaries of clerical and shop assistants.
4. Sales invoicing.
   Accounts payable.
5. Calculation of future prices, based on past costs.
6. Financial accounting including:
   Manufacturing costs.
   Retailing costs.
7. Stock control of finished goods at shops and warehouses together with inter-shop transfers.
8. Analyses of sales.

The two applications seen were: (*a*) Calculation of future prices, (*b*) Payroll.

Calculation of Future Prices

This application consists of revising current cost and price lists by addition of the latest knowledge of costs for existing products and the estimated costs of new products. The addition to existing products takes into account the machine hours, operatives' labour and overhead costs applied to the quantity manufactured.

Payroll

In order to carry out the wages calculation, individual punched cards for all workers are put together into a single stack of cards. These are sorted in ascending order of department and worker's number. The cards for each individual worker comprise personal data card, the rate per hour, accumulated gross salary for year, normal deductions, bonus hours for period, special payments, displacement card when a worker moves outside his usual department, additional payments for learning new work, home worker's card, home worker's card showing special bonus, overtime card, amendment to basic rates, absence card, any special deduction. After sorting, the cards are used for a check run through the computer to test for completeness, sequence and any errors in punching. The use of this check obviates the necessity for verification of cards. The time taken for the check amounts to 20 minutes.

The program is read into the computer and stored on the magnetic drum. In the read-punch unit blank cards are fed for cumulative gross wages 1 and cumulative gross wages 2 and coinage for cash department. The cards which were previously checked are placed in the fast reader.

The central processor now calculates the gross wages per worker. This consists of piecework, hourly rates, overtime, cost of living, special bonuses, payment in lieu of holidays, etc. In the same operation, net wages are calculated by subtracting the deductions which can consist of old age and dependent's insurance, health and unemployment insurance, fines, advance payments, loans, rents, etc.

The individual items comprising gross and net pay are printed on two forms side by side. One statement is handed to the employee with his wages. The other statement contains additional information regarding hours worked, holidays taken and outstanding, guaranteed wage comparison. Simultaneous with the printing of the statements, cards are punched showing accumulated

earnings per individual employee and amounts to determine the coinage required. Certain other figures are stored on the drum for subsequent operations.

The coinage cards and cards showing deductions are then placed in the fast reader; these combined with other figures stored on the drum produce lists giving detailed information for each factory. Subsequently total cards are punched giving book-keeping data together with pay-out sheets.

The next operation is the preparation of a productive work schedule. This consists of comparing corresponding cost figures for previous period last year and listing out current cost data with percentage ratio to last year. This is followed by the preparation of an indirect cost schedule.

Further operations supply lists showing:

- Piecework and indirect charges, showing whether work performed in own or another department.
- Time lost by employees.
- Statistics for Swiss Footwear Association.
- Holiday hours per employee.
- Advance calculation of holidays.
- Accident insurance.
- Old age and dependents' insurance.
- Superannuation Fund.
- Statement for employees' tax deductions.

The time taken to complete the whole of the above for 1,200 employees is 2½ hours. This time represents one-eighteenth of time taken on previous punched card system.

GEG Hamburg (Co-operative Wholesale Society)

GEG was founded in 1894. It serves 300 retail organisations with 9,200 retail shops. The annual turnover is £200 million, and it has 68,000 employees. *GEG* manufacture or factor 18,000 products and issue 1,000,000 invoices per annum.

The problem was how to speed-up the rate of invoicing to provide the branches with current statements showing dates on which accounts are due for payment and to highlight overdue accounts.

GEG have manufacturing centres which are spread over Germany according to the product manufactured. They also buy from other sources. Normally products are forwarded from manufacturing centres to the retail centres and then distributed to the retail shops. In certain cases, such as perishable goods, the retail branches frequently obtain goods direct from manufacturing centres or other sources.

When it was decided to investigate the sales invoicing system, *GEG* used consultants to analyse the system, and did not use their *O & M* department. Once the decision was taken to instal a computer, two programmers were engaged and these with assistance from *Remington Rand* provided the programs.

The installation which is the standard *Remington UCT* comprises:

- Processor.
- Read-punch unit.
- Card reader.
- High-speed printer.
- 8 key punches.
- 6 verifiers.

In addition to the above, 3 key punches and 5 verifiers are held in reserve against possible breakdown, and 4 key punches are used for training.

The verifiers and key punches are similar in that they accept cards and eject them automatically. To verify a card, the information is punched and then verified by photo-electric cells. No mark is made on the original card.

Further equipment includes:

- Form and carbon separators.
- Machines for cutting and trimming forms.
- 3 sorters.
- 2 collators.

The staff consists of the following:

- 1 computer operator and an assistant.
- 2 maintenance engineers.
- 2 programmers plus 3 from manufacturers.
- 30 punched card and allied staff.

The normal daily shift is 9 hours, commencing at 8.30 a.m., but this is flexible, having regard to the work required. Preventive maintenance commences 1 hour before computer required for productive work. Unscheduled maintenance is approximately 2%–3% of the 9-hour shift, and is caused by faults on

- printer,
- read-punch unit,
- high-speed reader,

in order of the most troublesome one first. The faults are mainly mechanical (card jamming) as opposed to electrical.

Thirteen programs have already been written; 10 of these are in actual use. Most of these programs utilise the maximum amount of storage.

The programs in use include:

- Invoicing.
- Sales day book.
- Daily sales analysis.
- 10-day sales analysis.
- Monthly sales analysis.

Invoicing System

All products are divided into groups, each group comprising a maximum of 300 products. A batch of cards is held for each group containing product numbers, descriptions, turnover tax code and other standard information for each product within that group.

One card is kept for each customer in respect of each

group of products, recording the customer's account number, address and other relevant standard information.

When orders are received from customers, delivery notes are made out by hand at the warehouse, recording:

Customer's number.
Product number, or numbers.
Unit prices of products.
Quantities of products.
Percentage of discount.
Freight charges.
Invoice number.

The unit prices are not obtained from the computer, as they fluctuate from day to day in most cases, and differ from centre to centre. The unit price includes a margin to cover "turnover tax."

Copies of the delivery notes are sent to the computer centre and cards are punched with the information listed above. A maximum of three invoice items can be recorded on one card. All items on one delivery note will always belong to the same group of products.

The cards recording sales are sorted to product group/customer order and are separated into product groups. Each group, in turn, is then merged on the collator with the address cards for that group, out-sorting address cards for which no order has been received.

Cards are then fed into the computer continuously in the following order, using the fast card reader:

1. The invoicing program.
2. Cards containing standard information about products in the first group.
3. Merged address and sales cards relating to the first group.
4. Cards containing standard information about products in the second group.
5. Merged address and sales cards relating to the second group,
   etc.

Blank cards are fed into the Read/Punch unit, and invoice forms are placed on the High Speed Printer.

As soon as the program cards have all been read, the program takes over control, the first group of cards containing standard information is read, and the printing of invoices begins.

The computer extends the prices, computes and discounts and turnover taxes (the latter being paid by the selling organisation at several different rates, dependent on the type of product, and whether or not it has his own manufacture). Invoices do not contain items from more than one group of products as this assists the Retail Branch in checking.

Cards are punched, containing the total value for the invoice, turnover tax amounts and invoice amounts, customer's account number, invoice number and product group number.

It is intended that the computer will prepare every three days from these invoice cards, a statement showing balance at end of last period, less cash received, and a list of invoices rendered during the past three days.

The Sales Day Book

The invoice total cards just punched, are used as input and one line printed for each invoice, recording:

Product group.
Customer's account number.
Invoice amount.
$\left.\begin{array}{l}\text{Turnover tax}\\ \text{Discount}\end{array}\right\}$ Group 1.
$\left.\begin{array}{l}\text{Turnover tax}\\ \text{Discount}\end{array}\right\}$ Group 2.

Totals are printed for each product group.

Daily Sales Analysis

The daily sales analysis from the sales cards punched from the delivery notes. Invoice total cards are also read and then the totals from each compared. The analysis shows the value of goods sold for each product within each product group, with a total for the product group.

Other Statistics

Other figures are obtained from the same source, for example, a breakdown of the value of goods sold according to the warehouses in which they are stored.

GEG Application

The application is one which a computer with a fast printer is able quickly to show economic justification as it is one of repetitive nature, and the cost of the installation has already been justified in staff savings, and the quick turnover of cash and statistics provided.

It is estimated that the total printed matter exceeds 13,000,000 lines per annum. There would appear to be a further additional saving possible if the typing of the despatch notes provided the initial data either by punched tape or punched cards.

Conclusion

From the short time available, it is not possible to speak other than in general terms.

It would seem that the *UCT* is an up-to-date machine, compact and for its price a relatively fast machine, and all the persons using the machine were extremely pleased with the performance and reliability.

With the customary efficiency of the German and Swiss personnel, systems have been revised and used on the computer in a matter of months. The actual personal punching of cards has been reduced to a minimum by the use of the photo-electric verifier and the fact that the majority of the cards are a product of the computer.

THE FUTURE OF AUTOMATIC DIGITAL COMPUTERS

by Andrew D. Booth

(Inaugural lecture to the Bristol Branch of *The British Computer Society, Ltd.*)

Before discussing the future I want to talk about the past, which I find a source of disappointment. One of the things which prompted me to give the lecture its title was that a number of people who should know better have recently given tongue and pen to the statement that "new, second generation computers are with us" and that these machines are better than anything which has been thought of before. The first part of this lecture will attempt to disabuse you of this idea for, far from thinking that any second generation computer exists, I think that we are only just seeing the growing up of first generation computers. To justify this statement I remark that, in 1946–7, I worked with the late John von Neumann on the logical and physical design of computing machines. Von Neumann wrote, at the Institute for Advanced Study at Princeton, two reports[1,2] on aims and objectives to which we may look to see the type of computer which was envisaged at that time. This computer was in fact a machine having, in retrospect, certain rather interesting characteristics. The most obvious of these is speed of operation and this was desired to be such that a 40 bit addition or subtraction would take about 10 micro-seconds. There is no computing machine commercially available in this country which achieves this addition time. The multiplication time of the von Neumann machine varied from 400 micro-seconds for the crudest scheme to 50 micro-seconds for a more sophisticated logical device which still made no use of the steam-roller electronics to be seen in at least one machine of the present day, which achieves a rather worse performance. So much for second generation speed!

Next, the store. We were thinking in 1947 of a high speed store for 4,096 words of 40 bits. I remark that it is only in the last couple of years that machines have been produced with storage organs whose total capacity is of this order of magnitude and many machines which are currently manufactured have high-speed storage for only one hundredth of this number of data. Yet again, early in 1947, a highly integrated backing storage using magnetic wire was developed and, although wire is now out of fashion, the important thing is that the system itself was a well integrated one, well suited for handling the large quantities of information required in the solution of non-linear partial differential equations. Had it been put into service, it would have been equally suitable for "data processing."

The main reason for the comparative failure of the Princeton machine was that it relied for storage on a secondary emission device called the Selectron[3] which unfortunately did not materialise.

A binary parallel adder with the required speed of operation was actually constructed at Princeton in 1947 by Richard Snyder. Unfortunately it contained certain analogue elements which performed the operation of obtaining the sum digit at each stage by means of the algorithm:

Sum digit = Sum of incident digits — twice carry.

The analogue elements required precise setting by means of potentiometers and, for this reason, the scheme was not adopted. It is interesting to speculate on the effect which modern high stability components might have had on this development. The really interesting fact which remains over from these pioneer days is that accelerated carry schemes, either using propagation gates or staticisors, and carry end detection, were well understood and the propagation gate device was embodied in the accumulator of my own machine A.R.C. So much for the claims of novelty of "modern" engineers.

Micro-programming, too, is of some antiquity, having been invented by Dr. K. Tocher in the early 1950's, although it already formed a part of most teleprinter systems!

Finally there has been much talk lately about "time sharing," a supposedly new idea for computers in which they will interrogate various priority stations and break off from doing a bread-and-butter job in favour of a priority job. In fact this has been envisaged for many years and involves nothing new. No special instructions are really needed since all existing computers can be programmed to do just this by the use of branch instructions and the normal input or inputs. It may be that it is better to provide special facilities on big installations, but this is not by any means necessarily the case and no new idea is involved.

The overall picture of present computing machines which have developed over the last ten years is as follows: First, the single storage organ, the basic idea of von Neumann, has, except for medium speed magnetic drum machines, been forced into abeyance. The reason is that the only high speed element that has become available is the magnetic core. The magnetic core matrix contravenes a fundamental principle laid down in 1947: that no large scale store for a computing machine was practicable if it used physically distinct elements. This *volte-face* has been forced upon designers

by the march (or rather the backward march) of progress. Fortunately the position is not quite as bad as it appears, since a number of programming studies seem to show that a high-speed store, which some people put as low as 10 words and none higher than 1,000 words, plus a large magnetic drum, produces a net slowing down of the machine of from 1% to 20% according to the optimism of the evaluation and the particular problems under investigation. Thus present machines consist, not of one store, one arithmetic unit, and so on, but of two stores, a high-speed store of limited size and a backing store of between 8,000 and 30,000 words.

In addition to cores and drums magnetic tape is just appearing on British machines, although it has been on American machines for some time. The history of magnetic tape in this country is one of muddled thinking about the way in which magnetic tape might improve the performance of a computing machine, and of muddled experimentation on the way in which errors arise from magnetic tape. Magnetic tape has two possible functions in a machine, the first as an input and output medium, and the second as a very large capacity, low-speed backing store. As a direct input and output one problem, both here and in America, is that no simple and adequate mechanism for direct input from a keyboard on to magnetic tape has been developed and, with the exception of the Xerographic printer, a like remark applies to output. This means that information must be punched on paper tape or cards and processed either through the computer itself or by a special magnetic tape preparing device. Two rivals to magnetic tape are already visible: the file drum—a large device for storing a few million bits on a slow speed but otherwise classical magnetic drum; and the so-called RAMAC or "juke-box memory." As inventor of the magnetic drum, I obviously favour the file drum, but I cannot help admiring the immense technical virtuosity of a device like a stack of gramophone records which in about a third of a second will move a recording head up to a given level, rotate it into position and drop it on to a prescribed track on a disc. Despite this admiration, however, I cannot help saying that I do not think it will stay in the field for very long.

I have mentioned paper tape and punched cards. Which are best? Both have certain advantages. For example, card-handling mechanism is more reliable than that for paper tape at the present time, this is perhaps due to the fact that numerical information has until recently, been non-redundant, so that, when a punched card calculator manufacturer produced a machine, he did not put in checking digits, he assumed that his machine was going to work most of the time. With paper tape, in the telegraph industry, the situation was rather different. Probably without realising it, manufacturers of paper tape equipment made use of the redundancy of language, and this meant that they did not have to transmit messages very accurately. I once put this point to a firm of telegraph equipment manufacturers who were horrified at the mention of one error in 10^9 as an acceptable fault rate for computer equipment, since they considered 1 : 5,000 as good and 1 : 50,000 as phenomenal!

So much for the overall picture of machines. What of the constituent components?

Semi-conductor diodes are the staple diet of the computing machine designer. They require no heater supply, they are well enough understood so that circuits can be designed without much experiment, they can be easily and reliably manufactured. I think that the diode will eventually replace most other passive elements in future machines. Transistors will be used for power amplification, diodes for computing. Both the diode and the transistor suffer from hole storage effects, but these are likely to be better understood and controlled in the future, and are unlikely to inhibit progress towards faster machines. There is one important way in which junction diodes and transistors differ from thermionic valves: their impedance levels are from 10 to 100 times lower. Low impedance is very important since it means that a computing machine can be built which will be relatively free from pick-up of extraneous noise pulses. The elimination of heater supplies is so obvious an advantage that it hardly requires mention, but I believe that the main impact of solid state devices on computer technology will lie in the improvement of reliability and not in the mere reduction in size. Although a sprawling monster the size of a room is undesirable, one much smaller than an office desk is equally awkward both to service and to manufacture. The only place where a small computer is really justified is in a moon rocket.

So much for the past. To attempt a prediction of the future we look at what is in the laboratories at the present time and try to see which laboratory devices are likely to be practicable in computing machines. The mesa and the drift transistor are two such elements which may be useful for power amplification at 1,000 megacycles, and the tunnel diode is likely to provide a logical element of equivalent speed.

Ferrite cores will supply the high-speed storage of computers for probably two years whilst other things are being developed. Ferrite cores are getting smaller, easier to handle, and more reproducible in production. They form a reliable storage medium in the speed range of 0·5–5 microseconds.

The most promising new element is the thin magnetic film. Experiments have already shown[4] that information can be written, read and re-generated in times of the order of 10 milli-microseconds. This is faster, by a factor of 50, than the speed attainable with ferrite cores. Perhaps even more important, the speed is such that the "light barrier" is looming up. The light barrier occurs when the time of transit of a signal from one side to the other of the computer becomes appreciable in terms of the arithmetical speed. For example, propagation across a distance of 30 cm. takes one milli-microsecond, and several modern computers have dimensions which are from 10 to 100 times as great as the figure quoted. This effect will introduce considerable complexities in

computer design and probably means that the ultimate arithmetical speed will not exceed one milli-micro-second for addition. The problems which still remain to be solved for thin films are, firstly, those of reproducible production of matrices, a technological problem which should not present much difficulty, and secondly, the problem of designing an efficient access system. With speeds of the order mentioned, it becomes difficult to conceive, let alone develop, physical mechanisms for selecting, writing and reading. One interesting aspect of thin film techniques is that, despite the small quantity of magnetic material present in any storage element, the output produced is still quite large (20 mV in some cases). This is a direct consequence of the fast rise times of the interrogating pulses.

Even more exotic elements for storage and arithmetical units of the future depend upon superconductivity. The first of these to be described was the "Cryotron" of Dudley Buck[5]. This device makes use of the fact that in the presence of an applied magnetic field the temperature of incidence of superconductivity is reduced. It happens that Niobium is less sensitive to the destruction of its superconductivity by applied fields than is Tantalum and this makes possible the Cryotron flip-flop shown in Fig. 1.

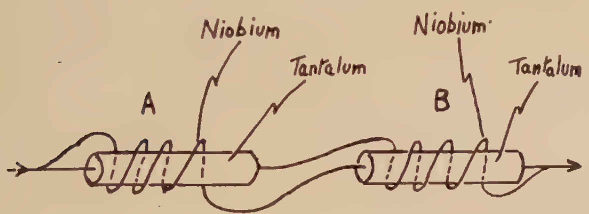


Fig. 1.—Cryotron flip-flop

The operation of this device is as follows: the circuit is cooled to 4·2° K in boiling liquid Helium. In the absence of current all of the materials are superconducting but, as the applied current, I, is increased, a point is reached at which the field generated by the Niobium forces the Tantalum wire to assume its normal, ohmic, resistance. Because of small asymmetries in the layout this will occur in one side of the circuit before the other. If this is assumed to be in side A in the diagram, the increased resistance of the associated Tantalum wire will keep the current in the Niobium wire of B below the de-superconductivity point. The arrangement is thus stable. From symmetry the state in which B is superconducting and A is normal is also stable, so that the device behaves as a flip-flop.

It is clear that the flip-flop can be set and reset by means of gates constructed in the same manner from Niobium coils on a Tantalum wire, so that all of the prerequisites for a computing machine are present.

Unfortunately the speed of operation of the original Cryotron is relatively slow (10^{-2} sec), but by vacuum deposition of thin film elements it is claimed that this figure can be decreased to 10^{-6} sec or less.

The Cryotron in this form is not directly suitable for a large capacity store, but two variants have been proposed for this purpose by *IBM*, the *Ramo-Wooldridge Corporation* and *Duke University*. One of these is shown in Fig. 2.

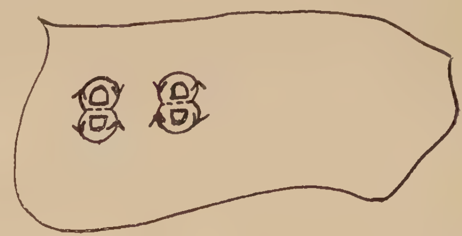


Fig. 2.—Superconductive store

A thin superconducting film is vacuum deposited upon an insulating substrate. In this film are "D"-shaped openings separated by a narrow bridge. Data are inserted and read by means of wires along the bridges and to which current pulses are applied. It is clear that a current can flow in one of two directions along a bridge and that such circulating currents can be produced by the magnetic fields generated by the wires just mentioned.

It is claimed that operating times of 10^{-8} sec can be attained by the "Persistor," as it is sometimes called.

The importance of superconducting elements is likely to increase as satellites and space-probes become more common, because of the natural insulating properties of the inter-planetary vacuum. Even without this incentive, however, superconductivity is an attractive element for large computers because of the relatively small power dissipation. It is worth noting that the Helium which is used can be recovered, liquified, and used over and over again.

A depressing commentary on so-called progress is that von Neumann and the author discussed a superconducting storage element, almost identical with that shown in Fig. 2, at an evening party in 1947. Unfortunately, by morning our enthusiasm, like the liquid Helium, had evaporated!

Another of the more exciting things which magnetics hold for the future has appeared quite recently in the physical literature. It arises from work done by Ludwig Meyer,[6] in the United States, on the direct reading of magnetically recorded information by means of electron-mirror-microscopy. In this work we may be seeing the future equivalent of the file drum or the juke-box store. The reading process is a static one which depends upon the deflection of the electron beam in an electron microscope by the magnetic field of the data recorded on a magnetic film of conventional type. One advantage of

the process is that the inherently great magnification of the electron microscope makes the reading of closely packed data easy; another advantage is that the reading element is an electron beam which can be deflected electrically and thus facilitates high speeds of operation. Naturally the advantages of non-destructive read-out are still present, as with the magnetic drum.

Even if this were the only feature of Meyer's work it would be exciting, but he has also shown[7] how information may be written on to a magnetic medium by means of an electron beam. This is achieved by magnetising the medium initially by means of an external field, and then heating small regions above the Curie point by means of a sharply focused electron beam. When the material cools below the Curie point again, an inversion effect takes place and this enables the electron mirror microscope to detect the previously heated spots. Meyer suggests that information densities of 10^5 bits/cm^2 will be possible and that the writing speed might be 10^5–10^6 bits/sec.

In the general field of input-output equipment clearly the magnetic tape will come into general use. Xerography, too, is likely to be applied both to printing and to replacement of punched paper or film. A second form of recording, "Digitape" based on "Teledeltos" paper, is, I think, less likely to be perpetuated because of its expensive basic material. Devices for the direct reading of printed characters are at present moderately unreliable. The imperfections of print, and especially of typewritten print, present quite considerable technical difficulties to the designer of a machine which, independently of context, will recognise any given printed character with great accuracy. By using context the problem is rendered easier and such an extension of the basic character reader is almost inevitable. Direct recognition of the spoken word is on the horizon. One possible application is to stocktaking, where a pocket recorder and lapel microphone would leave hands free for inspecting the stock.

My feeling on all questions of input-output is, however, the less the better. The ideal use of a machine is not to produce masses of paper with which to encourage Parkinsonian administrators and to stifle human inventiveness, but to make all decisions on the basis of its own internal operations. Thus computers of the future will communicate directly with each other and human beings will only be called on to make those judgements in which aesthetic considerations are involved.

References

1. Burks, A., Goldstine, H. H., and von Neumann, J. *Preliminary Discussion of the Logical Design of an Electronic Instrument.* Princeton, 1946.
2. Booth, A. D., and Britten, K. H. V. *General Considerations in the Design of an All Purpose Electronic Digital Computer.* Princeton, 1947.
3. Booth, A. D., and Booth, K. H. V. *Automatic Digital Calculators*, 2nd ed., p. 145, Butterworths, 1956.
4. Bradley, E. M. Private communication.
5. Buck, D. A. *Proc. I.R.E.*, Vol. 44 (1956), pp. 482–93.
6. Meyer, L. "Electron Mirror Microscopy of Patterns Recorded in Magnetic Tape," *J. Appl. Phys.*, Vol. 29 (1958), pp. 658–60.
7. Meyer, L. "Magnetic Writing with an Electron Beam," *J. Appl. Phys.*, Vol. 29 (1958), pp. 1454–6.

DISCUSSION GROUPS

Since the inception of the Society and prior to that, during the existence of the London Computer Group, Study Groups have been operating during each winter session. It had been felt at the beginning of the current session that in order to reflect more accurately the present nature of these Groups they would be renamed Discussion Groups. In November 1959 all members in the Greater London Area and any other interested members received details of some fifteen proposed subjects. The response to this proposal resulted in the formation of eight Discussion Groups as follows:

No.	*Name*	*No. of Members*
1	Input and Output	35
2	General Accounting	24
3	Feasibility Studies	28
4	Operational Experience	19
5	Advanced Programming	27
6, 7, 8	Production Control, Scheduling and Stores Control	35
9	Operation Research in Business	15
15	Statistics	15

It has been decided that these Groups will continue not only until the completion of the current session but will recommence immediately with the same membership at the start of the 1960–61 session. Members of the Business Group Committee will keep in touch with these Groups by attending periodic meetings.

New members will be welcome to join these Groups subject to the number of active members currently attending. If required extra groups will be formed and also occasional new "Subjects" will be put forward through the medium of the *Bulletin*. In this connection, reasoned suggestions from fellow members are always welcomed.

The response to the other Groups mentioned in the November circular, which included those suggested for scientific and engineering members, was such that their formation into working entities was not possible

P. V. Ellis

TOWARDS A COMMON PROGRAMMING LANGUAGE (3)

In previous articles (*The Computer Bulletin*, Vol. 3, No. 1, p. 9, and Vol. 3, No. 3–4, p. 64) the Research Committee on the Standardisation of Scientific Programming Notation has made suggestions concerning some aspects of programming on which common conventions might be adopted, at least for the purpose of publishing programs.

The Committee has now turned its attention to one of the more powerful techniques of programming, the use of subroutines. In one form or another subroutines enter into almost every scheme for simplifying programs, yet the Committee has found that if care is not taken any attempt to introduce a convenient general notation for subroutines may lead to ambiguities. These are of a fundamental nature and are likely to arise whatever type of notation one employs; they are studied here in the context of scientific programming. The following article tries to resolve these ambiguities without adding unnecessary complications to the coding language.

The suggestions made here do not cover all the cases which can arise, and it is intended to publish a further article covering subroutines which form parameters of other subroutines. Meanwhile readers are invited to send their comments to the Secretary of the Committee (Dr. S. Gill, Ferranti Ltd., 68–71 Newman Street, London, W.1).

* * *

Notations for Subroutines

Introduction

It is customary to break down a large program into subroutines which reflect the natural subdivisions of the problem. In many cases the individual subroutines will be written by persons who are not necessarily familiar with other parts of the program, or even with the overall plan. For this reason it is desirable that the subroutines in a program should be self-contained not only in themselves, but also in the notation that expresses them. For example, if a name (say x) is used for a working variable in one subroutine, it should also be possible to use it in another without confusion. On the other hand, it may be desirable to reserve a name to have only one meaning throughout a program. It is clear that such reserved names cannot occur within subroutines intended also for the "library," without removing from the user the ability to use what names he chooses. We shall discuss this matter in more detail later.

In general a subroutine will perform some calculation on data provided by the main routine, and return control to the main routine when it has finished its task. The subroutine has to be told where to find the data and where to place the results, and these details are usually known as the parameters of the routine. The "data" and "results" may include control numbers: for example, there may be an auxiliary routine used within the subroutine, or the task in question may be a complex discriminatory operation which results in a return to the main routine at several alternative places.

**

It is conventional to distinguish between "open" and "closed" subroutines. An open subroutine is a sequence of instructions copied into a program, so that control enters and leaves the subroutine by normal sequencing, just as if it were an instruction of the machine's code. The closed subroutine is quite different: it is separated from the program using it, and entered by a special sequence of instructions which we shall term the "calling sequence." If the subroutine is used several times in the program at different places, only the calling sequence is repeated, not the subroutine itself. Since an open subroutine can always be converted into a closed subroutine we shall only consider notations for the latter. This is preferable because the notation for the use of a closed subroutine will merely be the notation for the calling sequence. The notation for the subroutine itself will be in a different place and there will be only one copy of it.

The notation for subroutines therefore has two parts, for the subroutine itself and for its calling sequence which appears at some point in the program using the subroutine, together with statements to set the parameters for the particular use required at that point. We shall regard the setting of parameters as a function of the program using the subroutine, and not as a function of an input or assembly program. This means that all parameter settings are considered as being made dynamically. To save repetition of such settings we shall adopt the convention that parameter settings remain in force until changed, regardless of how many times the subroutine has been used in that part of the program.

Notation for the Subroutine Proper

In a later section we shall discuss calling sequence notation; here we deal with notation for the subroutine proper. It is recommended that a subroutine be headed by a title statement of the form

subroutine X or simply routine X

where X is an appropriate identifier, for example "smallest root," and this is the name used in the calling sequence.

In most cases a subroutine will be entered at the first instruction (in order of writing) but if this is not the case it will be necessary to indicate the entry point, for example, by writing

enter ⟶

by the side of the first active instruction.

In the case of multi-purpose subroutines, it is necessary to identify the different entry points. This can be accommodated in the notation by giving all the entry names in the title statement, and using these names

within the subroutine to show the corresponding entry, for example

routine: sin/cos
sin) ————
————
cos) ————
————

The statement "exit" can be used to indicate the dynamic end of the subroutine. It need not of course be the last statement written, nor need it occur only once in the subroutine, but it always indicates the same exit route. The end of the subroutine as written should be indicated by a horizontal line on the page.

Within the subroutine we must list the parameters, which can be done immediately below the title. For this purpose a statement such as

parameters: $A, B, C, \ldots$

is suggested, where A, B, C stand for the names of the parameters as used *within* the subroutine. Any name used within the subroutine for variables, statement labels, etc., and not listed as parameters or quantities common to the main program, are local to the subroutine and carry no meaning outside the subroutine.

Example: A subroutine to calculate $y = (ax + b)^2$.

routine: PARAB
parameters: $y; a, x, b$
$z = ax + b$
$y = z^2$
exit

In this example z is a working space variable of purely local significance.

Calling Sequence Notation

We have indicated that the use of a subroutine will require two things to be done, the setting of parameters and the entering of the subroutine. We recommend two basic statements for these actions.

When parameters are to be set, a correspondence must be indicated between the names of the parameters as used within the subroutine and in the program using the subroutine. A statement using the imperative "Set" is suggested. This takes the form:

set: $X\,(A \equiv \alpha,\ B \equiv \beta,\ \ldots)$

where X stands for the name of the subroutine, $A, B, \ldots$ are the names of its parameters and α, β are the corresponding *names* used in the main routine.

There is an important logical distinction between "input" parameters (such as a, x, and b in PARAB) and "output" parameters (such as y). With the former type it is possible to specify numerical values or computable formulas in place of names in the parameter setting statement. To distinguish whether we are setting names or values we may employ $\equiv$ for names and $=$ for values, e.g.,

set: PARAB $(y \equiv w,\ a = 10,\ x \equiv t,\ b = \lambda + \mu)$

Alternatively if it is felt desirable to emphasise even further the difference between the two types of setting, we could write in place of the above

rename: PARAB $(y \equiv w,\ x \equiv t)$
set: PARAB $(a = 10,\ b = \lambda + \mu)$

In either case it is understood that when a subsequent

do: PARAB

statement is encountered, the PARAB routine is executed with the current value of t in place of x, with the value of $\lambda + \mu$ at the time of setting in place of b, and with $a = 10$, and assigns as the new value of w the result named y in the subroutine.

The "Do" statement can also set parameters by following it (in parenthesis) by parameter setting equations as in the following example, which is intended to illustrate the dynamic properties of the foregoing conventions.

Program	*Resulting operation expressed in nomenclature of main routine*
set: PARAB $(y \equiv x,\ a \equiv u)$	
...	
...	
...	
$u = 10$	$u = 10$
...	...
...	...
...	...
do: PARAB $(x = y,\ b = u)$	$x = (10y + 10)^2$
...	...
...	...
...	...
$u = 4$	$u = 4$
...	...
...	...
...	...
do: PARAB $(x = 6)$	$x = 34^2$

This example also illustrates the property of the notation of being able to use different names for the same quantity in the main routine and in the subroutine, and even interchanging names, as in the case of x and y above.

"Function" Subroutines

The scheme just described is suitable for dealing with general routines involving several parameters. In the case of "function" subroutines, however, where only one

result parameter is involved, it seems more natural to write, e.g.,

$$q = p + 2af(2t^2 + 1)$$

where f is defined by the subroutine

routine: $f(x)$
parameters: y (implicit); x

$$\boxed{\begin{array}{c}\text{instructions for}\\ \text{computing } y = f(x)\end{array}}$$

end

rather than (say)

do: $f(y \equiv z, x = 2t^2 + 1)$

$$q = p + 2az$$

(In these statements f denotes a suitable string of identifying symbols).

If there is more than one argument their positional significance is indicated in the title; thus PARAB could be renamed as follows:

routine: PARAB (a, x, b)
parameters: y (implicit); a, x, b

The use of the positional notation is to be regarded as setting *values*; the setting of *names* is only relevant when parameter setting is divorced from the execution statement. As an illustration of how this might be done, the example given earlier is reproduced using the positional notation for PARAB

set: PARAB $(a \equiv u)$

.
.

$u = 10$

.
.
.

set: PARAB $(b = u)$
$x =$ PARAB $(-, y, -)$

.
.
.

$u = 4$

.
.
.

$x =$ PARAB $(-, 6, -)$

Here – denotes "the value or name last set."

Contraction

It is very convenient to be able to define a function by means of a statement of the form

$$\text{let } f(x) \equiv f(x, a, b) = x^3 + ax + b + \lambda$$

This is to be regarded as equivalent to the subroutine

routine: $f(x)$
parameters: y (implicit); x, u, v, w

$$y = x^3 + ux + v + w$$

end

together with a parameter setting statement of the form

set: $f(u \equiv a, v \equiv b, w = \lambda)$
or: rename $f(u \equiv a, v \equiv b)$
set: $f(w = \lambda)$

in place of the "let" statement in the main routine. If subsequently we write

$$f(t)$$

the effect will be to compute $t^3 + at + b + \lambda$, where a, b take their current values, and λ retains the value which it had at the time of defining $f(x)$.

The properties of the parameters in a "let" statement should be clear from this example. Thus those on the left are only set when the function is called; those in the middle which do not appear also on the left are set by *renaming*; while those which appear only in the formula on the right take the values which they have at the time of contraction.

An important special case is when there are no parameters other than those in the middle of a let statement, e.g.,

$$\text{let } f(x) \equiv f(x, a, b) = x^3 + ax + b$$

In this case we may abbreviate it as follows:

$$\text{let } f(x) \equiv x^3 + ax + b$$

it being understood that *all* parameters other than those on the left are set by "naming" at the time of the "let" statement.

The term contraction refers to the reduction in the number of parameter settings which have to be made each time the function is called. It can also be used to eliminate them altogether. Thus, for example,

Let $r \equiv r(x, y) = \sqrt{(x - a)^2 + (y - b)^2}$

$x = x_0$
$y = y_0$
→ $\phi = a_1 r + a_3 r^3 + a_5 r^5$
compute new values of x, y
test
↓

In this example the single letter r has been employed as an identifier, which can only be done of course if there is no possibility of confusion with another variable. The quantity r will be re-evaluated at each cycle; indeed at each encounter of r unless the compiler includes a test to see whether the *values* of x and y have been changed.

Reserved Names

In the foregoing, the notation has been based on the

idea that each subroutine has its private set of symbols for variables and that the equivalences between the names of the same quantity is made by "setting phrases."

Where a quantity bears the same name throughout the whole program (including the subroutines) there is no need to use parameter setting phrases for name setting if the following convention is observed. If a quantity has the same name in the program using the subroutine as in the subroutine itself then no setting phrase is required, provided the quantity is named as a parameter of the inferior routine. A consequence of this rule is that where the whole program is constructed as a many level hierarchy of subroutines a quantity that bears the same name in all divisions of the program need not have any parameter setting phrases, provided it is explicitly stated to be a parameter of all subroutines that use it (directly or indirectly).

This convention gives flexibility to the user of the notation in that he may choose in which parts of a program a parametric name will have the same meaning.

Finally we make a suggestion for economising the notation for lists of parameter names. If a list itself be labelled then another list of parameters can be made to include those contained in the first list merely by referring to it by its label. Thus if we wish to reserve a set of names to apply throughout a program we can write these names as parameter names of the main program and to the parameter lists for each subroutine add a phrase such as "and those in LIST 1" where LIST 1 is the label for a parameter list in the main program.

ACCESSIONS TO LIBRARY, JANUARY 1960

Periodicals

Automation Progress. Vol. 2, 1957, no. 7; vol. 3, 1958, nos. 5, 6.

Computer Applications Symposium. Proceedings 29–30 October 1958 (5th year).

Computers and Automation. Vol. 5, 1956, nos. 1, 4–12; vol. 6, 1957, nos. 1 pt. 1, 2–6.

Elektronische Rechenlagen (ER). Vol. 1, nos. 1–48 (February 1959).

Engineering. 13 November 1959 (Computer revolution in small firms, p. 473).

Electronic Forum for Industry Bulletin (EFFI). Vol. 1, no. 1, 1959.

Faculty of Actuaries Transactions. Vol. 26, 1959, nos. 198–9.

ICT. Issue no. 2.

Industrial Equipment News. Vol. 6, 1957, no. 15; vol. 7, 1958, no. 24.

Institului Politehnic din Iasi Buletinul. Vol. 4 (8), 1958, nos. 1–2.

Instrument Construction (trans. from the Russian). 1959, no. 1.

Journal of Machine Accounting. Vol. 10, 1959, nos. 1–7, 9.

Journal of Mechanical Engineering Science. Vol. 1, 1959, no. 1.

Mathematical Reviews. Vol. 19, 1958; vol. 20, 1959, nos. 1–7.

Production Equipment Digest. Vol. 1, 1954, nos. 1, 4–7; vols. 2–5 (1958).

Provisional International Computer Centre Bulletin. 1959, nos. 4, 5.

Other Material

Brit. I.R.E. Journal.

Abstracts over the past 18 years.
Selected abstracts 1946–58.

British Conference on Automation and Computation.

Joint symposium . . . 1959. Books A and B.

British Iron and Steel Research Association (BISRA)

Conference on computers . . . April 1958.

British Computer Society Ltd.

Reports of London study groups 1958.

BUSAMCO (Kimball Division).

The Kimball system of automatic data processing.
Kimball station punch.
Automatically with Kimball.
Simple sales analysis with Kimball.
Re-ordering automatically with Kimball.
Warehouse; stores: ADP centre.

DSIR

Radio research special report no. 28. Conversion of ionospheric virtual height-frequency curves to electron density-height profiles. 1959.

Automatic control in Soviet industry. A report of a visit to the Soviet Union in May, 1959, to study progress in automatic control applied to industrial production.

Mullard Ltd.

The design of a standard block for a digital computing system. Reprinted from Mullard Technical Communications, vol. 4, no. 38, April 1959.

Solartron Electronic Group Ltd.

Solartron Data Sheets:
Solartron process response analyser JY743.
Analogue computer. Servo units.
Direct-coupled operational amplifier type AA621.2.
Minispace analogue computer.
Process response analyser JY743.
Analogue tutor TY963.
Space "30" analogue computer TY922.
Solartron Computer Service (brochure).

CORRESPONDENCE

Letters from readers are welcomed, and should be addressed to The Editors, The Computer Bulletin, Finsbury Court. Finsbury Pavement, London, E.C.2. The name and address of the writer must be given, but will not be published if requested.

A Common Language

Sir,

At present the Society has a group of people investigating the use of a common language for Computers for scientific purposes, and it is apparently intended to set up a similar group to investigate the use of a common language for business purposes.

It would seem that the purpose of these groups is to produce two artificial languages which can be rapidly translated into machine language by various automatic coding routines to be developed for all Computers. It is obviously impractical to have one code language which all machines will work on as different machines being developed for different purposes will naturally require different instructions, and consequently different coding.

It strikes me that the *British Computer Society* already has its own common language (English) which can be used as input. All machines can be programmed to convert English into their own machine language just as easily as they can be programmed to convert any artificial language into machine language. It would therefore seem that the whole investigation and/or invention of a common language is unnecessary, and should one be developed, that the time spent by programmers in translating their English thoughts into this common language is a complete waste of time, as the time to be taken by the machine to convert any language into machine coding remains necessary.

The use of the English language for this purpose has already been developed to a certain extent by the *Remington Rand* Flowmatic Programming System, and it would seem that the best course for the Society to adopt would be a thorough investigation of this process and to continue further developments along the lines already undertaken by Dr. Grace Hopper in her Philadelphia Laboratories.

Perhaps, however, the use of the English language which we all understand is too logical for this purpose.

Yours, etc.,

J. W. Mitchell

52 *Shirley Drive,*
Hove, Sussex.

* * *

A Need for Precision

Sir,

Mr. Mitchell is right in pointing out the possibility of English as a common language and both committees on automatic programming that he mentions are now in operation and have studied the use of English. But I feel Mr. Mitchell over-simplifies the problem either through lack of knowledge on auto-coding or over-idealised concept of the English language.

Programmers in this country and elsewhere are trying to use English; but one of the difficulties is to put discipline into the use of words so that a common language always uses the same terms. For instance, the standard term might perhaps be "read" rather than "input" or "bring in" or the many other synonyms with which the English language abounds. Similarly, a decision has to be taken on whether to use "test," "compare," or "check," and also to define the course of action to take. It is no use just saying, "Compare Stock on Hand with Quantity Ordered," one must also agree on how to define all the various conditions that could arise such as "if greater than," "if equal to," "if less than," "if greater than or equal to," "if not equal," "if less than or equal to" or perhaps in another form "zero," "positive" or "negative."

One cannot allow users to write their instructions in any form of English words they like since the computer would not know how to interpret them. The words and phrases permitted must be limited and given a strict meaning so that no ambiguity can arise—and their meaning must previously have been defined to the computer by a special processor or translator master program. Mr. Mitchell will find that his own firm's Flowmatic works in this way.

The present work is being undertaken in the hope that the situation can be avoided where each manufacturer has his own system of English words and phrases, therefore requiring a different language for each machine. The search for a common English language aims to make it easier for the systems analyst to express his procedures for all makes of computers, but the analyst must still learn some standard form of permitted verbs, nouns, clauses, etc., in order that his expressions will be precise and understood by the computer.

Committees working on scientific and mathematical problems have not found English logical and precise enough to cover their statements, and therefore are developing some form of algebraic expressions to exactly define their terms to a computer. There is no reason for Mr. Mitchell to feel indignant about this since outside a computer, mathematical symbols, not English, are normally used for this type of work. *Remington Rand* themselves have a different system from Flowmatic for mathematical work.

I think it can be seen, therefore, that English may be useful for commercial applications but much work remains to be done both on the "common language" and the translators and processors.

Yours, etc.,

R. M. Paine,

Chairman,

Committee on Auto-coding for Business Problems.

Conversion from One Radix to Another

Sir,

In a letter in your December issue, Mr. Tylden-Pattenson described a method for converting "from a low to a higher radix." At least for manual work this is available also for conversion from a high to a lower radix. In the latter case, products by the (arithmetical) difference of the radices have to be *added*, instead of subtracted, and all working (and carry transmission) takes place as in the notation of the *smaller* radix. An improperly large digit for the smaller radix may temporarily occur after the positions in which a separating point was shown in Mr. Tylden-Pattenson's scheme: this admittedly may raise some problems if a *mechanised* conversion routine is wanted. It is no inconvenience at all for mental work with pen and paper. To illustrate:

Example 1.—Convert $(1\ 5\ t\ 3)_{12}$ to its decimal representation (t = digit "ten"):

$$\begin{array}{cccccl}
1 & 5 & t & 3 & & \\
 & 2 & & & & (1 \times 2) \\
\hline
1 & 7\cdot & t & & & \\
 & 3 & 4 & & & (17 \times 2) \\
\hline
2 & 1 & 4\cdot & 3 & & \\
 & 4\cdot & 2 & 8 & & (214 \times 2) \\
\hline
2 & 5 & 7 & 1 & &
\end{array}$$

$$(1\ 5\ t\ 3)_{12} \equiv (2\ 5\ 7\ 1)_{10}$$

Here all working is in the scale of 10.

Example 2.—Convert $(2\ 5\ 7\ 1)_{10}$ to its octal equivalent:

$$\begin{array}{cccccl}
2 & 5 & 7 & 1 & & \\
 & 4 & & & & (2 \times 2 = 4)_8 \\
\hline
3 & 1\cdot & 7 & & & \\
 & 6 & 2 & & & (31 \times 2 = 62)_8 \\
\hline
4 & 0 & 1\cdot & 1 & & \\
1 & 0 & 0 & 2 & & (401 \times 2 = 1002)_8 \\
\hline
5 & 0 & 1 & 3 & &
\end{array}$$

$$(2\ 5\ 7\ 1)_{10} \equiv (5\ 0\ 1\ 3)_8$$

Example 3.—Convert $(1\ 5\ t\ 3)_{12}$ to its octal equivalent:

$$\begin{array}{cccccl}
1 & 5 & t & 3 & & \\
 & 4 & & & & (1 \times 4 = 4)_8 \\
\hline
2 & 1\cdot & t & & & \\
1 & 0 & 4 & & & (21 \times 4 = 104)_8 \\
\hline
3 & 2 & 6\cdot & 3 & & \\
1 & 5 & 3 & 0 & & (326 \times 4 = 1530)_8 \\
\hline
5 & 0 & 1 & 3 & &
\end{array}$$

$$(1\ 5\ t\ 3)_{12} \equiv (5\ 0\ 1\ 3)_8$$

In *Examples* 2 and 3 all working is in the scale of 8.

The operations of the radix-conversion algorithm are fundamentally the same as in the repeated synthetic divisions required in the algebraic problem of change of origin for the argument of a polynomial, using detached coefficients.

The algebraic counterpart to *Example* 1 would be the problem: "Express $x^3 + 5x^2 + 10x + 3$ as a polynomial in $x - 2$."

The working would involve repeated synthetic divisions by $x - 2$, in a scheme such as

$$\begin{array}{cccc}
1 & 5 & 10 & 3 \\
\cdot & 2 & 14 & 48 \\
\hline
1 & 7 & 24 & \lfloor 51 \\
\cdot & 2 & 18 & \\
\hline
1 & 9 & \lfloor 42 & \\
\cdot & 2 & & \\
\hline
1 & \lfloor 11 & & \\
\cdot & & & \\
- & & & \\
1 & & &
\end{array}$$

to indicate that

$$x^3 + 5x^2 + 10x + 3 \equiv (x-2)^3 + 11(x-2)^2 + 42(x-2) + 51,$$

where all numbers are in ordinary decimal notation.
Putting $x = 12$ we have $(x - 2) = 10$ and so establish that

$$\begin{aligned}(1\ 5\ t\ 3)_{12} &\equiv 1000 + (11 \times 100) + (42 \times 10) + 51 \\ &\equiv 2571_{10}.\end{aligned}$$

In the corresponding conversion algorithm, this table is in effect completed not by successive horizontal lines, but by successive upward diagonals, with appropriate carries naturally taking place towards more significant digit positions. Thus

$$\begin{array}{cccc}
1 & 5 & 10 & 3 \\
 & 2 & & \\
\hline
1 & 7 & & \\
 & 2 & 14 & \\
\hline
1 & 9 & 24 & \\
 & 2 & 18 & 48 \\
\hline
1 & 11 & 42 & 51
\end{array}$$

leads to the working of *Example* 1.

In converting to a radix other than 10, multiplications and additions or subtractions must be done *in the notation of this other radix*, to secure an analogous result.

The method is in fact general for conversion between any two radices. For machine work it is more convenient in conversions to a higher radix. In unassisted work it is rather more convenient for conversions into the scale of 10, from another radix either higher or lower, but quite feasible in other cases also.

This may have been appreciated at the original source where the separating points were introduced.

Yours, etc.,

T. H. O'Beirne

Barr and Stroud Ltd.,
Anniesland,
*Glasgow, W.*3.

Computer Delinquency

Sir,

It is often said that the trouble with machines is their need for human operators and operating errors certainly appear to have been major factors in the incidents to which Mr. C. R. Merton refers in his letter published in the August/September issue. Detailed reports show that in the first case an electronic calculator was unfairly given an undebugged program to work upon, while in the second a computer input device was improperly prodded by a programmer who attempted to correct a simple mechanical fault.

The impression which the newspaper reports left with Mr. Merton is not sustained by the fuller accounts of the events nor by the substantial experience of the use of similar machines. Some tens of thousands of weekly or monthly payrolls employing the same principles and machines similar to the so-called "haywire brain" have been reliably and promptly prepared over a number of years, while the mechanism which encountered a human digit pushed well into its "works" has been used for about 40 years; general design changes have altered its style in recent models, but the old device served in thousands of equipments without incident.

Most machines hit back from time to time (the writer can remember finding his tie neatly wound around a typewriter platen) but such events seldom reach the front pages of national newspapers. Computers, along with jet aircraft, atomic power stations and rockets, however, make good copy, especially when they appear to misfire.

If we think this harms our interests perhaps we should look first to the publicists in our own ranks.

Yours, etc.,

A. H. Wright

17, *Dallaway Gardens,*
East Grinstead,
Sussex.

* * *

Tape Editing Equipment

Sir,

The editorial of the June–July 1959 *Bulletin* was headed, "Autoprogramming and the Technical College." Unrelatedly about that time the College had decided to buy a CREED REPRODUCER set for use in conjunction with the MERCURY at I.C.I. Wilton and with the PEGASUS at Durham University. Delivery is now expected in early March. Initially the equipment will be used with Autocode courses and a three-year part-time day course in Numerical Mathematics, Statistics and Computing which the College, in common with a number of other large colleges, is offering.

Yours, etc.,

W. A. Greig

Constantine Technical College,
Middlesbrough.

Noise Reduction

Sir,

The replies given, at a Discussion Meeting on Reliability and Maintenance of Digital Computer Systems (21 January, 1960), to a question on the prospect of a reduction in the noise of peripheral equipment indicate that this problem is seriously neglected. Of three speakers associated with manufacturers of such equipment one made no comment, one simply advocated enclosing the equipment in boxes, and one suggested that the noise is something we must learn to live with.

Experience has shown that human efficiency is adversely affected by noise. Remedies which merit wider use include overhead cowls such as one finds in record shops, resilient mountings to reduce acoustic shock through the floor, sound absorbent walls, ceilings and baffles, quite apart from improvement in the design and materials of the offending mechanisms. Perhaps the fault lies with the users, whose increased protests might stimulate manufacturers to greater efforts, and who might themselves make more strenuous attempts to damp out noise in computer rooms.

Yours, etc.

W. L. C. Garrett

National Research Development Corporation,
1, *Tilney Street,*
*London, W.*1.

British Engineers Visit U.S.S.R.

During May 1959 a team of six British control engineers, headed by Professor A. Tustin, went to the U.S.S.R. to visit a number of computing centres and computer design laboratories as well as institutes concerned with factory automation. Among the computers which they saw were the fast BESM II and the interesting new "SETOON" which operates in the scale of 3.

The aspect of Russian technology which made the greatest impression on the visitors was the enormous training programme for future scientists and engineers which was getting under way. Copies of a report on the visit may be obtained from the Honorary Secretary, *BCAC* (Group B), c/o *IEE*, Savoy Place, London, W.C.2, or from the *DSIR* Lending Library Unit, 20 Chester Terrace, Regent's Park, London, N.W.1.

MERCURY for BP

An order for MERCURY has been placed with *Ferranti Ltd.* by *The British Petroleum Co. Ltd.*

The system, costing over £¼ million, will be one of the fastest in the United Kingdom for processing data. The extensive ancillary equipment includes a converter unit which transfers information from magnetic tape to punched cards and vice versa, and facilities for printing data from magnetic tape on very high speed printing units.

The system will be used by *The British Petroleum Co.* for both scientific and commercial applications. It is anticipated that the system will be installed in one of the Company's head office buildings in London around the turn of the year 1960–1.

LONDON MEETINGS

Members who are familiar with the computer installation picture in the *UK* might have wondered about the computer Mr. R. L. Sutton of *Confederation Life Association* would be referring to in his talk to the Society on "The First Year's Experience with a Large Computer in a Life Assurance Office" given on 5 January this year.

It did not take us long to discover that this computer—a large scale magnetic tape system—was housed in the Company's Head Offices in Canada. Mr. Sutton had spent some time over there and was involved with the early programming effort. All the documentation is done centrally by the computer and one of the earliest difficulties to arise was standardisation of the meanings of terms between the overseas offices. It was quite clear that this Company had deeply committed itself to the use of an *EDP* system and that much of the Company's future depended on the success of this venture. So far there had been no cause for anxiety. I do not recall any details being given for "fail safe" procedures. I believe that this effort will give added stimulus to those of our members who are actively engaged with the application of computers to business. I am sure that we all wish this Company every success. There is every hope that this paper will be published in one or other of the Society's publications.

The next meeting—given in the afternoon of Wednesday, 27 January—attracted more people than was expected and for the first time we had to contend with standing room only. The centre of attraction was a talk on "Storage Elements for Very High Speed Computers" given by Mr. W. D. Lawson of the *Royal Radar Establishment*. Some time, someone might write about the important role played by this Establishment to the engineering development of the computer in this country. I refer particularly to the many familiar names of computer designers and engineers who did war-time service at Malvern. It therefore seemed natural that we should be given an account of research going on there which will play an important role in the future development of computers.

Mr. Lawson first dealt with the work going on with cold storage devices. These devices depend on the phenomena that super-conductivity (zero electrical resistance) displayed by some materials at temperatures below 8° absolute (−265° C) can be destroyed in the presence of a magnetic field of a threshold value depending on the temperature and the material used. He described two methods for setting up this magnetic field. In one method the switching time was relatively slow but the units could be assembled to give logical functions—the alternative method gave higher speed switching, somewhere between 100 and 10 milli-microseconds, and was potentially useful as a storage device. Mr. Lawson then dealt with developments in thin magnetic film techniques. The basic principle here is that it is possible to set up a pattern of regions (domains) on a thin film of, say, nickel and iron alloy within which the residual magnetic field must lie in one or the other direction along an axis which can be set in advance. The direction of this field can be determined and so we have a two-stage device which can be switched and whose state can be determined. The advantages of these techniques are that relatively high packing densities are possible with very high switching speeds—theoretically lower than 1 milli-microsecond. The curious twist to this development is that here we have a storage device whose switching speeds have outstripped the electronic techniques to deal with them, that is, once again has a leap-frog jump from the store been the limiting factor to the electronics. We were grateful to Mr. Lawson for his assurance that this new problem could be solved.

Conversion between Analogue and Digital Representations

About 150 members and guests attended a whole-day discussion meeting on "Conversion between Analogue and Digital Representations" on 17 December at Northampton College, London. Sir David Mackworth, the chairman, controlled the meeting well, and questions from the floor were frequent.

The first speaker was R. H. Tizard who gave an excellent survey of the principles and methods which have been used. Subsequent shorter contributions dealt with particular aspects or devices; on shaft digitisers there were four speakers. Some of the large range of optical digitisers and resolvers made by *Hilger and Watts* were described by D. S. Evans. Although, experimentally, a resolution of 10 seconds of arc, or 0·0001 inch in linear form, has been achieved, nevertheless optical methods are also suitable for many low-accuracy applications. Using electrical contacts, the three-decade digitiser described by E. J. Petherick (*Benson-Lehner GB*) has ten output wires for each decade, to simplify both the construction and the avoidance of ambiguities. The system also provides for the remote choice of datum angle. The *GEC* induction digitiser (C. J. Wayman) uses flux linkage to give a five-bit output in reflected binary cyclic permuted code. In a theoretical contribution, G. C. Tootill (*RAE*) explained that it is possible to combine the properties of chain codes and cyclic permuted codes, so as to reduce the bulk and complexity of a digitiser.

The conversion of a voltage analogue to digital form, using transistors as switches, was dealt with by T. Hore (*Mullard*) and also by R. J. Corps (*RAE*) whose requirement arose in connection with mixed analogue and incremental digital computing elements. The *Mullard* device gives 10 bits, sampling the input every 1 ms. Another *RAE* voltage digitiser, giving 14 bits, was exhibited by D. W. Allen.

As an intermediary in the *Ferranti* system for automatic control of a machine tool, data is represented by phase modulation. Conversion between this and digital representation, by feedback methods, was D. F. Walker's subject. G. B. Cole (*Panellit*) spoke on methods of transferring data from several digitisers to a *GP* computer.

The general discussion centred round some provocative statements on reliability, by J. F. M. Scholes (*ICT*), and a survey of the commercial situation in America, by E. J. Petherick.

LONDON MEETINGS

Change of Date

Mr. Stafford Beer will now give his talk on "Automation and Uncertainty" on *Thursday* 21 *April* at 2.30 p.m.
at
The Northampton College of Advanced Technology,
St. John Street, London, E.C.1.

REGIONAL BRANCH NEWS

BELFAST

There were three meetings of the Belfast Branch of the *British Computer Society* during the autumn of 1959. The first was the season's introductory lecture on 15 October, with the intriguing title, "Computer Facts and Fallacies," given by Dr. A. D. Booth who discussed many of the lesser known limitations of computer equipment and tried to destroy the myth of the high costs necessary to remove them. The second meeting had to be postponed and this probably had an adverse effect on the attendance when Mr. D. R. Jones of *IBM* gave a talk on 3 December, on "The Application of an *IBM* 650 to Payroll and Labour Costing." Mr. Jones outlined the 650 system emphasising its possibilities as an integrated system and took as a particular application the payroll of the North Staffs area of the National Coal Board involving the thorny problem of bonus payments.

On 8 December, Dr. A. D. Buckingham gave an interesting lecture on "The Solution of Ordinary Differential Equations," including a lucid exposition of the problem of determining the stability of various numerical methods of solution.

BIRMINGHAM

The 1959–60 programme of the Birmingham Branch began with meetings on university computers, new machines and bank accounting equipment.

At the first meeting in October, Dr. A. S. Douglas gave an illustrated lecture on the installation of the PEGASUS Computer at Leeds University. He described the work in crystallography and engineering science which was used to justify the application to the University Grants Committee for a capital grant, and the problems involved in selecting the most suitable computer. He stressed the need to consider not only the characteristics of the computer itself, but also the auxiliary facilities such as the library of programs and sub-routines.

Dr. Douglas then discussed the siting of the computer for the convenience of the main users, and the staff required, and described the use of the machine for teaching, research and service work for the University administration and outside bodies. He concluded with an analysis of the proportion of computer time devoted to production and program development and lost due to faulty operation. As with other computer installations, the last two items have decreased considerably since the commissioning date, the time lost through faults having fallen to only $2\frac{1}{2}$ hours in an operating time of about 200 hours per month.

At the November meeting Mr. K. Tylder-Patterson described the new machines exhibited during the *UNESCO* conference on data-handling in Paris. He concentrated particularly on the foreign machines which had not been shown in this country and were thus little known to most branch members, and described some new facilities available in data processing computers, such as parallel programming and the use of variable word lengths systems.

Mr. Tylder-Patterson also described a number of interesting auxiliary units, such as the Facit "Carousel" random access tape store, which depart from conventional practice.

He concluded with a description of some Japanese computers embodying an important new computing element, the parametron, and recent German and American investigations into the design of high-speed parametrons.

At the December meeting we were joined by a number of visitors from local banks, for a talk on "Bank Automation" by Mr. W. A. Freymenfeld. The speaker described the type fount standardised by the American Bankers Association and the arrangements for printing with magnetic ink and reading the characters by a magnetic head. He pointed out the advantages of some form of correlation detection for recognising the characters, and the need to allow for imperfect printing and registration.

Mr. Freymenfeld next described the special purpose machines which had been developed to help mechanise the handling of accounts, starting with the machine for printing each cheque with the name of the bank, the branch and the account number before it is issued to a customer. The next machine required is somewhat larger; it encodes the handwritten amount on a received cheque in magnetic ink and also lists all cheques handled and compiles a running total.

The largest machine is the sorter, which handles 1500 cheques per minute and sorts them into 13 stations in accordance with a selected digit or digit combination of the magnetically printed code. This machine can also be used with remote control as a reading-in device for supplying the data to a digital computer, or for producing a magnetic tape for high-speed computer input.

The final item is a special purpose digital computer with facilities for transferring information from the cheques to ledger cards and simultaneously calculating additional items such as bank charges. The computer uses binary-coded decimal notation, with 100 words of rapid-access core storage and the programmes are punched on loops of mylar tape.

In conclusion Mr. Freymenfeld gave estimates of the cost of the system when handling hire purchase accounts and bank accounts.

The lecture was illustrated by two interesting colour films showing details of the machines and their operation.

BRISTOL

The Bristol Branch of the Society was formed in the latter part of 1959, and it was decided to commence activity with three lectures to stimulate interest and membership in the area.

The first lecture was held on 14 January 1960, when Dr. A. D. Booth addressed the Inaugural Meeting on "The Future of Computing Machines." A full account is given elsewhere in this issue.

The second lecture was arranged for Monday, 15 February, and was directed toward those with a commercial interest. Mr. T. C. Hickman of *Unilever* spoke on "Experience with an Electronic Data Processing Installation," and illustrated the talk by a film.

The last lecture of the series is to be held on Tuesday, 22 March, when Dr. J. Corner of the *Atomic Weapons Research Establishment*, Aldermaston, will interest the more

scientifically minded by his lecture entitled, "Digital Computers in Atomic Energy Research and Development." This meeting will be held in the Engineering Department of Bristol University, and starts at 7.30 p.m.

CARDIFF

On 24 September there was a talk by Mr. M. H. Johnson of Ferranti Ltd. on "Important Developments which have taken place in Electronic Data Processing over the last Two Years." A conducted visit to the computer installation of Steel Company of Wales at the Margam Works, Port Talbot, took place on 22 October. On 26 November Mr. D. J. Hasell of Steel Company of Wales gave a lecture on the practical problems arising from installation of a computer. A talk by Dr. J. P. Cleve of the University Computation Laboratory, Southampton, on "Mechanical Translation of Languages," was given on 17 December.

Dr. R. J. Ord-Smith of Standard Telephones and Cables, Newport, gave the first two lectures of 1960. His theme was "Basic Principles of Programming." The first lecture took place on 28 January and the second on 25 February.

GLASGOW

Although three very interesting talks were arranged for the last three months of the year, only 25 members on average, out of the Branch strength of about 100, turned up to hear the speakers. Those who did attend, however, were well rewarded for their support.

In October Mr. L. R. Hiscock of *Solartron*, speaking in the regular meeting room of the Branch at the Royal College of Science and Technology, covered the field of optical and magnetic character recognition.

On the evening of Monday, 2 November, members heard a most interesting talk given by Mr. D. W. Hooper, Member of Council, who spoke on the problems of installing an *EDP* system. Mr. Hooper said that in the early days in the United States many computers were installed as "window dressing." Fortunately this had not occurred in the United Kingdom where the approach had been based on economic appreciation. The two principal reasons for the installation of computers were

(*a*) that they were very fast machines,

(*b*) that they had the ability to carry out accurately enormous volumes of work.

He emphasised that the economic use of a computer depends on the proper marshalling of the input data. Many computers failed since machines for processing output often failed to make full use of speed of output. *EDP* involved the setting up of a data factory, and organising the installation is very similar to the organising of an engineering factory. The whole flow of work from the time that data is first recorded until the time that the processed product is presented to management, involves the most detailed planning. He said it was particularly essential to have a tight control of all movements of cards and tapes in the Data Processing office. Each bundle of cards must be identified as to the number of cards contained and the processes through which the cards had to be passed or had been passed. No unauthorised person must be allowed to remove a single card from any bundle or to make any correction in tape. In the *National Coal Board* this problem is dealt with by having a special "Card Corrector" sitting alongside the Supervisor, who alone was authorised to correct cards. All corrected cards are tabulated and this tabulation is kept as a day-book record of corrections. The object, in his view, was to get the data factory operating at the minimum excess cost over expectation.

Mr. Hooper emphasised the need to examine critically the work that was to be processed. Existing procedures must be examined thoroughly before mechanising. He was very much opposed to the normal method of verification by punching, "holes in holes." A more satisfactory verification could be obtained by the use of control totals, totalling both the "Identification" information and the "Quantity" information, e.g. totalling the pay numbers of workers as well as their output.

One of the great advantages which the computer would give to management in future was that it would be used to limit the amount of information supplied. This would be done by printing out only significant variations after the computer had made the comparison with the forecast of performance.

The Branch members were the guests of the University for the third lecture when they were invited to attend the Louden Lecture given by Mr. K. Tylden-Pattenson of *Production-Engineering Ltd.* at the end of November. The subject was "New Developments in Digital Computers and their Industrial Application." Mr. Tylden-Pattenson concentrated on developments in hardware and illustrated his remarks with slides.

Besides listening to talks about computers, members were, over the three months, working away in two study groups. One on "Stock Control" followed up last session's deliberations on warehousing with the study of the control of tool stocks. The other on "Feasibility Study and Choice of a Suitable Machine" carried on where they had left off for the summer.

It would seem that the initial wave of enthusiasm of Glasgow members is subsiding somewhat now and that activities are to be left to those with a practical interest in computers. 1960 may well be a year of consolidation in the growth of the Branch.

HULL

The first of the autumn meetings was a visit to *Messrs. Reckitt & Sons* to see their NATIONAL ELLIOTT 405 installation. As on previous visits to the computing installations at *Blackburn Aircraft* and *Hull Corporation*, two parties were arranged because of the demand for tickets. These were held on 7 and 14 October 1959.

Mr. P. J. Lown gave the introductory talk, describing the installation, and Mr. F. C. Lee outlined the problem of invoicing, which was the first application to be tackled by the organisation. Certain features of the computers order code and the preparation of subroutine flow diagrams were also explained by the company's staff.

A film was shown which traced the life of the computer from the time that it entered the factory gates, covering the period of erection and testing of the installation, and finally illustrating the progress of a batch of data.

The computer and its ancillary equipment was then demonstrated, and closer inspection of the machine components was possible by those who were interested in more detail. Finally there was an opportunity for general discussion.

On 4 November 1959 it was the turn of the programmers to state their views following the highly successful panel discussion held in July at which managements' views on computers were heard. The members of this programmers' panel were Dr. R. J. Turton, chief programmer, and Mr. P. C. Bennett, a senior programmer of *Blackburn Aircraft Ltd.*, and Mr. R. D. Elston, chief programmer, and Mr. F. C. Lee, organisation and methods, of *Reckitt & Sons Ltd.* Dr. A. King of *Blackburn Aircraft Ltd.* was in the chair.

In the discussion, many questions were posed and many aspects of a programmer's work was considered both in the technical and commercial fields. The question of qualifications for programmers and the use of aptitude tests created a divergence of opinion. Computer codes were considered and an attempt was made to select certain features which the panel would like to see in an ideal machine, and this resulted in a discussion on autocodes. However, combining the requirement of simplicity for the commercial user and the need for flexibility for the scientific user resulted in a large and complex computer which also possessed a comprehensive autocode with its consequent disadvantages. In addition the creation and use of an international machine language was felt to be a not-altogether practicable procedure.

Checks and error safeguards were considered from the point of view of the need of comprehensive programme checks and computer reliability. It was generally agreed that it was unsafe to allow a long period of several hours of unchecked calculation to proceed on a computer, but that the normal incorporated checks were sufficient for shorter calculations.

On 2 December 1959 Mr. R. Hindle, Martins Bank, talked to the Branch on "Banker's Approach to Electronic Applications." Before speaking on the computer applications and equipment requirements, which have been the subjects of much discussion by the Clearing Bankers' Electronic Sub-Committee, Mr. Hindle outlined the British banking system, in particular the difficulties which arise from the use of a cheque system and the consequent enormous task of sorting. He also pointed out the rather ludicrous position of when a cheque having been received and presented to the bank, the receiver is immediately credited with that amount, and until that cheque has been through the clearing bank and presented to the payee and his account debited, both people are in possession of the same money. In comparison, the speaker outlined the continental and American systems, in particular the Italian system which is at the other extreme of the payee being debited as from the date on the cheque but the recipient only being credited as from the date of presentation, and since all accounts accrue interest neither party is credited with the interest in this intervening period.

The most promising improvement to the British system could be the widespread introduction of credit slips, which briefly means that a person would present to his own bank a list of accounts to be paid accompanied by the credit slips provided as part of the invoices. Not only do you save money on stamps, etc., but pre-sorting is possible by the bank and the payee is debited immediately, thus giving him at any time an up-to-date version of his account.

The various problems arising from the banking system were then considered in relation to the use of automatic techniques. The design of a suitable sorter and character recognition equipment had presented the greatest difficulty, but the investigations of the sub-committee are now reaching the stage of fruition. Different sorting methods were outlined and mark sensing techniques were illustrated including the American E.13b and the British *EMI* systems. The uses of magnetic ink and the difficulties created by over-stamping, etc., were considered, but according to the speaker most difficulties have been overcome and it will not be in the too-distant future that we will see the introduction of this new equipment. In fact, one bank has already ordered a computer and others may follow suit soon, since trial program testing runs are reasonably advanced.

In spite of very poor attendance at this last meeting it was felt by all those present, including many local bankers, that this had been one of the most informative and interesting of all talks in the Branch programme.

LEICESTER

On 15 October 1959 Mr. M. Woodger, of the National Physical Laboratory, spoke on "Efforts towards a Common Programming Language." An account of the relevant European meetings of the last few years was followed by a description of the structure and use of an algorithmic language, "ALGOL." Mr. Woodger expressed concern that if some such notation were not agreed upon, some less general working system could become finally established by usage.

At a joint meeting with the Leicester branch of the Royal Statistical Society on 19 November, Dr. K. D. Tocher (*United Steel Co.*) discussed "The Marriage of Statistics and Commerce in Operational Research." As well as dealing efficiently with statistical analyses of large amounts of data, a digital computer could be used to simulate directly the activity of a firm. The latter application may be realistic yet not mathematically involved, with otherwise unattainable possibilities of experimentation and management training.

A film evening was held jointly with the *Leicester and District Productivity Association* on 17 December. Mr. Bromley (*T. & G.W.U.*) was in the chair, and the films which were introduced by Dr. P. G. Wakely were "The Electronic Computer in Commerce" (*Unilever*) and "Time to Think" (*ICT*).

The first of the 1960 lectures was given by Mr. D. J. Spurrell (*J. Bibby & Sons, Ltd.*) on 14 January. He dealt with an investigation on animal feedstuffs using a STANTEC-ZEBRA. Linear programming was involved but this was only part of the story in a very complicated procedure.

LIVERPOOL

The first lecture on 23 September was given by Mr. J. Foden (*Ferranti Ltd.*) who described the whole range of Ferranti computers, not only giving a brief description of their characteristics but also some idea of their history.

On 29 October Mr. C. C. Ritchie (*Brunel College*) described the method of operation of analogue computers together with the type of work for which they were suitable. This was exemplified by some actual application with which he had been connected.

On 24 November Mr. A. J. Platt (*Pilkington Brothers Ltd.*) described his experiences from 1956 to date in choosing and installing a computer. This was a case study dealing factually with what occurred.

Study groups have been formed. A Beginners Group meet regularly once a month to consider "The Approach to a Computer."

On 10 September they were "Introduced to Computers" by Mr. Kirk of Liverpool University. This was followed by the film "Direct Line to Decision" introduced by Mr. A. J. Melbourne, B.Sc. (*IBM Ltd.*), on 15 October.

On 12 November Mr. Martin Webb (*ICT Ltd.*) gave a paper on "Input and Output Media."

To see a working computer the group visited the computer at the head office of *Pilkington Brothers Ltd.* to discuss the production control application there and see a demonstration of some of the programs.

A group to consider Production Control, including Stock and Material Control, is meeting in alternate months during office hours. Visits have been paid to *Pilkington Brothers Ltd.* and *English Electric Ltd.*

There is also a scientific study group co-operating with a similar group at the Computer Laboratory, Liverpool University, by joining in at the Numerical Analysis Seminars at the University.

MANCHESTER

On 13 October 1959 the Branch held its first meeting of the 1959–60 session in the Manchester College of Science and Technology. The meeting commenced at 7 p.m. with a talk by Mr. A. Young on "Computing in the U.S.S.R." Mr. Young is the Director of the Computer Laboratory at the University of Liverpool and also Chairman of the Liverpool branch of the Society. His interest in computers had been aroused by the need to do a larger number of computations in connection with his astronomical work on Variation of Latitude.

Mr. Young had recently visited Russia and had found that they had University Research Schools for general work and Research Institutes with precise objects; at the very highest levels the staff are often holding several posts in widely separated locations and this provides any liaison that may be necessary. He said that he was particularly struck by the fact that in Russia information regarding the results of research is freely broadcast to interested parties, whereas in the West there is considerable duplication of effort due to the maintenance of secrecy by manufacturers in their efforts to keep ahead of their competitors.

In Russia, each Research Institute has its own scientific secretary and one of his tasks is to search all foreign scientific papers for those that will interest the members of his Institute. When such a paper is found it is completely translated, analysed and commented on by the senior staff of the Institute; the whole is then duplicated and sent off to all interested parties. Whenever possible, tasks such as translation, analysis of statistics, etc., is done by completely separate bodies specialising in such work.

In his visit to Pulkova Observatory he saw a considerable amount of punched card equipment all of which had a very old-fashioned external appearance but which was very effective mechanically and electrically and which seemed to be most efficiently used; some of the machinery carried out combinations of functions which, as far as the speaker knows, were not done outside Russia. This leading astronomical research centre was not yet in possession of an electronic computer although it expected to receive one shortly.

In Moscow he saw a machine called the *BESM Mk* 1 which was completed in 1953 with cathode ray tube storage and facilities for doing floating point arithmetic. The speaker considered that at that time it was probably slightly in advance of the Manchester University Mark 1 machine. Since installation the machine had been fitted with magnetic core storage of 1,023 words and with an access time of 6 milli-seconds; in this particular machine, an instruction consisted of a word of 39 bits and was in fact a three address machine. Input and output by card reader and punch was slow and at the time of Mr. Young's visit experiments were being conducted with a battery of up to six readers and punches working in series in order to achieve faster rates of input and output. The whole machine consumed some 75 kW, its framework appeared to be built of timber and it had between three and four times the bulk of the Manchester Mk. 1. Again this equipment seemed to be most efficiently used.

The speaker believed that Russia was still behind the West in the design of computers and somewhat behind in programming for scientific work. Considerable research work is being directed, however, towards the use of computers for controlling factory production line work, with the eventual aim of having an automatic factory. One major team in Leningrad was doing linear programming for the railways in connection with steel usage, and had already been the cause of effecting considerable savings. The Russians were possibly leading the world in mechanical translation.

One machine which is in full production is the URAL, the thirty-eighth of which has just been installed in Leningrad University. This is a fixed-point machine with a drum store of 1,024 words and having auxiliary stores on magnetic cinema film; the input was described to him as being punched cinema film, but he could not get further details. (Could this be similar to punched paper tape?)

Another machine he heard of while in Moscow University was the STRELA. Its power consumption was 150 kW, it had cathode ray tube storage and a reputed mean error-free time of only 10 minutes. This, however, was one of the first machines built and was being replaced by a machine now under construction which he considered perhaps a little in advance of the Ferranti MERCURY.

Contrary to the British and American practice, the speaker found that in Moscow they did not maintain an extensive library of subroutines but that they often simply recorded the jobs done and by whom; previous users then acted as adviser to anyone who had a similar problem. In the BESM *Mk.* 1 functional subroutines could be used one at a time by plugging in the necessary special chassis. All computer codes appear to be arithmetical and had no alphabetical representation. In programming techniques, he considered that the Russians were generally behind, but this may not always be the case, as all mathematicians were now "Computer orientated" and in addition he found in Leningrad that all mathematicians took a common course for the first two-thirds of their five or six years' course, and that after separation some 25 per cent continued to receive an especial emphasis on computing in their instruction, the remainder continuing with numerical analysis to a greater or less extent. Enormous importance seemed to be placed on numerical methods in all mathematical courses.

A number of other impressions that Mr. Young had gained was that there seemed to be no miniaturisation, machinery was uglier and externally had not so good a finish as ours, although the equipment was generally very effective. It appeared that once a project was approved for a Research Institute, then all the resources of the country could be called upon to complete the job, and this included money as

well as man-power. Resources and efforts are integrated. Transistors were practically non-existent and no machines were yet transistorised. Impressive work, however, is being done on automatic programming systems.

Mr. Young read a few excerpts from a paper written by four Americans, Carr, Perlis, Robertson and Scott, whom he had met whilst visiting Russia. These excerpts in general confirmed the information and impressions that the speaker had gained. The paper has been published in *Communications of the Association for Computational Machinery*, Vol. 2, No. 6, June 1959.

The second Branch Meeting was held in the Manchester College of Science and Technology on 3 November 1959. On this occasion, Dr. K. D. Tocher, who is the Research Applications Manager in the Operational Research and Cybernetics Department of the *United Steel Companies Ltd.*, spoke to an audience of 24 members and visitors on "The Role of Computers in Operational Research."

Dr. Tocher set out to show how the advent of computers has affected the field of operational research and how operational research has affected the role of computers.

A Ferranti PEGASUS was used by all parties in the Company but it remained under the control of the Operational Research Department. One interesting point was that most of the non-operation research uses of the computer have developed out of operational research projects.

The speaker explained in considerable detail some of the problems concerning the flow of material in a rolling mill and how they were solved by the use of the computer. He then went on to give examples of work in the field of statistics. Here it was stated that a general multiple regression program had been expanded into a general statistical program that could print out scatter diagrams and print out histograms in diagramatic or tabular form. A lot of this programming work had been done in anticipation of the needs of the statistical personnel instead of waiting for them to come forward with their particular problems.

His department had also been doing dynamic program work and can now simulate the activities of a whole plant provided that all the factors are accurately observed and recorded. The simulation information is kept up to date by boxes on every machine, each having ten states; changes of state are immediately sent to a recording centre and put into machine language on punched paper tape; for this purpose a very powerful general simulation language for machine states had been developed. It is hoped that perhaps this simulation work eventually may lead to real time control of machines.

At a meeting held in the Manchester College of Science and Technology on Tuesday, 1 December 1959, Mr. W. E. Scott, who is the Manager of the Data Processing and Control Systems Division of the *English Electric Co. Ltd.*, spoke to over fifty members and visitors about the new English Electric Computer System—the KDP 10.

This system is of course based upon the RCA 501 but has been adapted to suit the British and European user.

The speaker started by giving his definition of data processing, describing what is required of a computer system and saying in what ways the designer of a system is forced to compromise.

The remainder of Mr. Scott's talk was a description of the KDP 10 system and in particular its order code, its immediate access store and the magnetic tape units. At the end of his talk, which was illustrated by slides and a model, the speaker answered a large number of pertinent questions which was no easy task as a number of our Branch members are employed in the computer departments of rival manufacturers.

MIDDLESBROUGH

The 1959–60 season opened in September with a visit to the British Railways Stooperdale offices at Darlington where a HEC 1202 is used on payroll work. In October Mr. D. Owen (*United Steel*) spoke on "Operational Research in the Steel Industry." In November Mr. J. E. Tinker (Cheshire Deputy City Treasurer) gave a comprehensive and enthusiastic account of the experiences of his Department in using an *IBM* 650 since June 1958. In December Dr. E. S. Page (Director, Durham University Computing Laboratory), under the heading "Preventive Maintenance—Is it Worth While?" discussed a possible mechanical model for measuring the efficiency of computer operation. A lively debate ensued between Dr. Page and certain computer engineers. In January 1960 Mr. N. C. Pollock (Manager, O & M Department, *Stewart & Lloyds*) gave a vigorous account of the use to which his firm were putting a LEO computer. Though mainly used for payroll work, an increasing number of technical problems were being programmed.

The membership of the Branch now stands at 33—a slight increase on last year. Interest on computers is strong on Teeside and visitors are welcomed; consequently attendances at meetings have been good.

All meetings have been held at Constantine Technical College at 7.30 p.m.

NEWCASTLE

The 1959–60 programme commenced with an open meeting held on 6 October 1959. This was fairly well publicised in the local press and by handbills and was attended by approximately 90 people. Dr. Page, the Branch Chairman, gave a few opening remarks on the rapid growth of the *British Computer Society* and introduced Mr. C. M. Berners-Lee, of *Ferranti Ltd.*, to speak on "Production Planning and Control."

Mr. Berners-Lee briefly outlined a business organisation and pointed to three main areas where a computer could have application, (i) material requirements, (ii) production planning, (iii) work scheduling. On (i) the use of magnetic tape records for part numbers and a random index was discussed, together with the advantages of a computer in rapid calculations for adjusted sales forecasts and comparisons of usage and stock. Under (ii), Mr. Berners-Lee illustrated the method of linear programming and its use in oil refineries, and briefly mentioned Q-theory. The use of computers for work scheduling was still in the development stage.

On 17 November Mr. J. E. Tinker, Assistant County Treasurer, *Cheshire County Council*, addressed the Branch on "Experience on an *IBM* 650." Mr. Tinker approached his subject from a practical viewpoint; he outlined the main functions of the Treasurer as paymaster, accountant and financial adviser, and traced the history of the equipment in the Treasurer's department from a conventional punched card set-up through the feasibility investigation to the purchase and delivery of an *IBM* 650.

The principles involved in their approach were discussed, for example the concept of an automatic office, treatment of staff, readiness to scrap the old system, and the aim to have as few exceptions as possible. Mr. Tinker went on to

outline the main job done on the *IBM* 650, namely payroll for 20,000 employees, and to mention other jobs such as road costing and loans accounting. Future jobs include budgetary control and medical statistics. In the ensuing discussion the economics of the installation was considered.

On 2 December Mr. A. Muir, of *United Steel Companies Ltd.*, spoke on "Linear Programming and Its Application." As he was addressing a mixed audience of commercial and scientific background, Mr. Muir began by recapitulating the main features of a problem as set out in linear programming form and went on to give examples such as cattle-food mixing, oil refining and transportation.

The method adopted for use on the STANTEC-ZEBRA was a revised simplex method employing the product form of the inverse. Besides storing and locking the original matrix, at each iteration a column vector of the transformation matrix was stored, together with an index for the variable omitted, instead of forming and storing the whole of the transformation matrix. An algorithm was developed, because of the large number of zeros in the initial coefficients, and the method proved more rapid than transformation of the whole matrix at each stage.

Mr. Muir ended by summarising the use and limitations of linear programming.

The meeting on 5 January was addressed by Mr. N. C. Pollock of *Stewarts & Lloyds Ltd.*, who took as his subject "Commercial Experience with a Computer." There were approximately 30 members and visitors and their attendance was rewarded by a very interesting lecture.

Mr. Pollock pointed out that the primary impetus for the installation of a LEO II computer had been given by the large scale clerical work at Corby and that there was a secondary consideration stimulated by the demand for a certain amount of scientific work. The main problem centred on input/output and buffer storage on the LEO helped considerably here. Mr. Pollock emphasised the value of practical demonstration and this had been achieved by using a computer on a service basis for several weeks before ordering; use on a service basis had continued until delivery of their own machine, which through careful preparation was operating three weeks afterwards.

A list of the operational jobs, both commercial and scientific, on LEO II at Corby at the end of November 1959, was circulated. This showed the proportion of operating hours taken by each job over the previous 61 weeks. The main one was payroll, covering 7,000 employees at the latest date. Mr. Pollock discussed the five major parts of this job and gave his interpretation of the use of human beings in relation to computer operation. A further commercial job, warehouse invoicing, was outlined. Mr. Pollock then illustrated the use of the computer on scientific work with two jobs, the anchor problem and ore-digging forecasts and acknowledged that the latter had not yet been very successful.

The speaker ended by summarising his main experience on computer operation, namely the necessity for accuracy of data, under-estimation of programmers required, value in service running, machine reliability, and a preference for reducing maintenance time, apart from marginal testing.

DEUCE USERS' COLLOQUIUM ON PARTIAL DIFFERENTIAL EQUATIONS

The DEUCE Users' Association held its fourth one-day colloquium on 6 October 1959 at the Russell Hotel. The subject was "Partial Differential Equations" and about 100 people attended, a similar number to previous colloquia. Dr. E. T. Goodwin, Superintendent of Mathematics Division, *National Physical Laboratory*, took the chair. On this occasion, for the first time, complete papers were circulated in advance; the organisers were gratified by the co-operation of the authors in this respect and intend that in future colloquia the papers will be circulated sufficiently in advance to be studied before the meeting.

The papers were divided into roughly cognate groups, each group being followed by a discussion period. Brief summaries of the papers are given below. A few of the papers are being considered for publication in *The Computer Journal* and complete copies of all papers may be obtained from the Librarian, *English Electric Company, Ltd.*, Data Processing and Control Systems Division, Kidsgrove Works, Kidsgrove, Nr. Stoke-on-Trent, Staffordshire, at a charge of 7s. 6d. to cover the cost of reproduction and distribution.

Session 1. *Methods of Solving Elliptic Equations*

Mr. B. A. Carré (*EE Co.*, Nelson Research Laboratories, Stafford).

General DEUCE programs for the solution of linear second order elliptic partial differential equations.

Programs have been written to solve elliptic equations of the form

$$a.\partial^2u/\partial x^2 + b\,.\,\partial^2u/\partial y^2 + c\,.\,\partial u/\partial x + d\,.\,\partial u/\partial y + f = o$$

where a, b, c, d, f and u are real functions of x and y, over complicated regions with straight or curved boundaries. Either u or its normal derivative must be specified at each point on the boundary.

The extrapolated-Liebmann method is used to solve the simultaneous linear algebraic equations obtained by substituting the normal finite difference approximations for the derivatives in the partial differential equation.

A system of codewords is used to specify any particular problem so that no special programming is required. There

are four programs which differ in respect of the number of mesh points that can be included, the largest square mesh being 56 × 56.

Mr. G. J. Tee (*EE Co.*, Mechanical Engineering Laboratory, Whetstone, Nr. Leicester).

Acceleration of convergence rates of iterative schemes.

The convergence of a wide class of iterative schemes for solving elliptic partial differential equations can be speeded by taking a linear combination of m consecutive iterates in place of the mth iterate itself, using coefficients derived from certain Chebychev polynomials; only two successive iterates of the accelerated scheme need be stored. It is shown that if the number of iterations in the basic scheme to obtain a certain accuracy is proportional to n^α, where n is the number of mesh points and α is some constant, then the number in the accelerated scheme is proportional to $n^{\alpha/2}$.

The method can be used when the matrix, which in the basic scheme operates on one set of residuals to produce the next, has real eigen-values. Thus it can be used with the point or line Liebmann method but not with the extrapolated-Liebmann method.

Mr. M. Woodger and Mr. G. G. Alway (*NPL*, Teddington).

The solution of a two-dimensional steady-state heat conduction problem with mixed boundary conditions.

Several methods of solving elliptic partial differential equations were compared by solving Poisson's equation for the temperature θ in the region $0 \leqslant x \leqslant t, 0 \leqslant z$, given θ for large z and its normal derivative on the other boundaries, there being a discontinuity in this value at one point on $x = t$. In all methods, the equation was replaced with finite difference equation $\underline{A}\underline{\theta} = \underline{b}$.

Method 1. Factorise $\underline{A}$ into lower and upper triangular band matrices and back-substitute.

Method 2. Partition $\underline{\theta}$ into vectors $\underline{x}$, each comprising the values of θ for a given z, partition $\underline{A}$ correspondingly and solve the resulting matrix equations for the $\underline{x}$'s by elimination.

Method 3. The extrapolated-Liebmann iterative method, with the accelerating factor under operator control; an efficient convergence appeared to be obtainable by judiciously alternating the factor between 1 and 2. An advantage of the iterative method is that the equations could be solved first on a coarse mesh and subsequently refined.

There was no large difference in times of solution by the three methods.

Dr. D. W. Martin (*NPL*, Teddington).

The Alternating Direction Implicit Method (ADIM) of Peaceman and Rachford for solving Poisson's equation in a rectangle.

A further method of solution was tried on the equation of the paper by Woodger and Alway. Matrix $\underline{A}$ was written $\underline{X} + \underline{Z}$, corresponding to the x and z components of the difference operators; the finite difference equation could then be written in two forms, one with $\underline{X}$ on the left-hand side and with the equations for θ for different values of z independent, and on the other with $\underline{Z}$ on the left-hand side and the equations for θ for different values of x independent. The two sets of equations were solved alternately with suitable values of a parameter introduced into the equation, initially using an estimate of the solution to form the right-hand sides, and subsequently using the previous results. It was proved that if matrices $\underline{x}$ and $\underline{z}$ commute, an exact solution is found in a specified number of cycles; the success of the method in the actual problem depended on the fact that this condition was nearly satisfied.

Session 2. Applications of Elliptic Equations

Mr. A. Gilmour (*EE Co.*, Data Processing Division, Kidsgrove).

The calculation of eddy currents in rectangular conductors.

Eddy currents in a typical switchgear busbar arrangement were calculated by solving partial differential equations in a two-dimensional domain comprising a number of separate rectangles inside a larger rectangle; the equations are, inside the small rectangles, Poisson's equation with a complex right-hand side and elsewhere Laplace's equation.

Mr. P. C. Birchall (*UKAEA*, Capenhurst).

The calculation of the influence coefficients of a symmetrically loaded and supported plate.

The deflection of a loaded thin plate is determined by the biharmonic equation with appropriate boundary conditions. The paper describes a program for calculating the matrix of stiffness coefficients, which are the coefficients in the equivalent finite difference equations. This matrix is inverted to give the influence coefficients which express the deflection in terms of the load.

Session 3. Simultaneous Elliptic Equations

Mr. N. D. Lam (*EE Co.*, Mechanical Engineering Laboratory, Whetstone, Nr. Leicester).

The simultaneous solution of Reynolds equations of hydrodynamic lubrication and the energy equation.

The pressure and temperature distribution in a bearing of given design satisfies a pair of simultaneous second-order elliptic partial differential equations. One of these was solved with an assumed temperature distribution to give a pressure distribution with which the other equation was solved to give a new temperature distribution, and so alternately to convergence. At each stage, the extrapolated-Liebmann method was used to solve the appropriate equation.

Dr. W. A. Green (*National Engineering Laboratory*, East Kilbride, Glasgow).

The solution of two simultaneous second-order equations of elliptic type (the (u, v) equations of elasticity) by an iterative method.

The problem was the determination of the macroscopic elastic behaviour of a material composed of perfectly rigid particles embedded in and firmly bonded to a matrix of known elastic properties. This reduces to solving the equations

$$\partial(\partial u/\partial x + \partial v/\partial y)/\partial x + (1 - \nu)(\partial^2 u/\partial x^2 + \partial^2 u/\partial y^2)/(1 + \nu) = 0$$

and

$$\partial(\partial u/\partial x + \partial v/\partial y)/\partial y + (1 - \nu)(\partial^2 v/\partial x^2 + \partial^2 v/\partial y^2)/(1 + \nu) = 0$$

where u and v are displacements in the Ox and Oy directions and ν is Poisson's ratio of the elastic matrix. The boundary consisted of a number of lines parallel to the axes (e.g. an L-shape).

Equivalent finite-difference equations were solved by the Liebmann procedure; two alternative sequences of calculating u and v values were tried and the results compared.

Session 4. Hyperbolic Equations

Mr. R. W. McIntyre (British Siddeley Aero Engine Company).

The Application of the Method of Characteristics to Nozzle Design.

The flow of air through an axisymmetric nozzle can, if the flow is assumed to be irrotational, be determined by solving a pair of first-order simultaneous partial differential equations for the two components of the velocity.

By introducing a velocity potential, the two first-order equations may be made equivalent to one second-order equation; this second-order equation is hyperbolic if the local velocity is supersonic, which was the case mainly considered. The equations were solved by the method of characteristics.

Two separate problems were considered, first the calculation of the performance of a given propelling nozzle and second the design of a blowing nozzle. These two problems have different boundary conditions, requiring two different methods of constructing the characteristics.

Session 5. Parabolic Equations

Mr. C. A. Forster (English Electric Aviation Company, Luton).

Temperature prediction in one-dimensional aerodynamic heating problems.

A number of methods are discussed of solving the unsteady heat-conduction equation for a plane homogeneous slab with temperature-dependent thermal properties subject to heating at the outer face.

One method used Runge Kutta techniques to solve the set of ordinary differential equations obtained by substituting finite difference approximations for the derivatives with respect to x, the space co-ordinate. Other methods used the Crank-Nicholson method after substituting finite-difference approximations for both spatial and time derivatives.

To avoid instability, the Runge Kutta method required smaller time steps than the Crank-Nicholson, which was twice as fast at its best, that is when only one iteration was required to solve the non-linear algebraic equations at each time step.

Various modifications are proposed in the hope of increasing speed. These include a transformation of the dependent variable and the use of more accurate finite-difference approximations.

Mr. J. S. Hornsby (Central Electricity Generating Board, Bankside House).

The solution of simultaneous diffusion and heat transfer equations representing the transient behaviour of a channel of a reactor subject to a disturbance.

Simultaneous partial differential equations were solved to determine the variation with respect to time and one space co-ordinate of thirteen physical qualities. A steady-state solution was obtained first by solving the ordinary differential equations obtained by putting the time derivatives equal to zero; this reduces to a non-linear eigen-value problem which was solved by an iterative method. The time variation due to a disturbance was then found by taking the steady state as initial conditions, replacing the spatial derivatives by finite difference approximations, and solving the resulting simultaneous ordinary differential equations by the Fox and Goodwin method II.

Mr. M. R. Wetherfield (EE Co., Data Processing Division, Kidsgrove).

Numerical solution of a parabolic equation with fixed boundary conditions.

The equation is

$$k\partial T/\partial t = \partial(T^{5/2}\partial T/\partial x)/\partial x$$

for $t \geqslant 0, 0 \leqslant x \leqslant 1$, where the initial value of T has a discontinuity at $x = 1$.

After an explicit method had failed due to instability, the Fox and Goodwin method II was used, with a time step first of 10^{-8} and then of 10^{-9}. The larger interval gave some initial oscillations in the value of T near $x = 1$, but when these had died down the two solutions were comparable.

Dr. N. E. Hoskin (UKAEA, Aldermaston).

Thermal Waves formed by the release of Wigner Energy in a bar of irradiated graphite.

An investigation was made to determine whether the release of Wigner energy in an irradiated bar of graphite could take the form of a self-propagating thermal wave. This entailed the solution of the normal one-dimensional heat-conduction equation with an extra term due to the generation of heat as the stored energy is released. The thermal conductivity and the specific heat are functions of the stored energy and thus of temperature. The method used for solving the equations was to divide the bar into N sections, throughout each of which it was assumed the temperature and stored energy had a parabolic distribution, and to replace the time derivatives with central differences. The accuracy of the calculations was checked by obtaining the solutions using half the original space and time intervals.

Mr. E. L. Albasiny (NPL, Teddington).

Solution of Equations of Radial Heat Flow with Chemical Reaction.

In order to examine the possibilities of electrical wire heating as a means of observing the kinetics of reactions between solids, a program was made to solve the equation of radial heat flow with cylindrical symmetry including an extra, temperature-dependent term for the heat generated by the reaction. A transformation of the radial co-ordinate r was made so that only the second derivative with respect to the new spatial variable remained in the transformed equation. Stable finite difference equations were obtained by replacing the spatial second derivative by the average of the second difference at the beginning and end of the time step, and by replacing the first order time derivatives by a forward difference. The resulting non-linear algebraic equations were solved by the Newton process.

COMPUTER COURSES 1959–60

The Education Committee has been surveying the courses offered during the academic year, 1959–60. Whilst it is not claimed that this survey is comprehensive yet it is hoped that members will gain a reasonable idea of facilities that are available, since the institutes concerned are likely to offer a similar selection of courses for 1960–61. (Owing to the lateness with which details of future courses become available it is not possible to print these in advance.) No system of classification has been adopted other than placing the 1960 courses after those beginning in 1959.

Readers will bear in mind that in addition to the courses mentioned below there have been the many excellent courses offered by the computer manufacturers.

Course	*At*	*Commencing*	*Fee* £ *s.* *d.*	*Lectures or Sessions*	*Times*
Design	Southampton University	Autumn term		30 weekly lectures	
Numerical Methods	Southampton University	Autumn term		30 weekly lectures	
Problems in Science and Industry	Birmingham C.A.T.	7 October	1 5 0	11 weekly lectures	
Programming for Pegasus	Birmingham C.A.T.	9 October	3 10 0	20 weekly lectures	
Commercial Applications	Birmingham C.A.T.	15 October	1 5 0	11 weekly lectures	
Programming	Coventry Technical College	September	1 0 0	12 weekly lectures	Wednesday 6.30–8.30 p.m.
Data Processing	Wednesbury County Commercial College	29 September	1 1 0	8 weekly lectures	7.00–9.00 p.m.
Electronic Computing Devices	Gloucester Technical College	1 October		6 evening weekly lectures	
Pegasus Programming	Computing Laboratory, Kensington Terrace, Newcastle	16 November	20 0 0	Full-time (16–27 November)	
Pegasus Autocode	Computing Laboratory, Kensington Terrace, Newcastle	30 September	5 0 0	30 September 2 November	
Pegasus Autocode	Computing Laboratory, Kensington Terrace, Newcastle	7 October	4 0 0	6 weekly lectures	6.30–8.30 p.m.
Industrial Applications	Applied Mathematics Department, Liverpool University	10 November	12 12 0	10–11 November	
Commercial Applications	Applied Mathematics Department, Liverpool University	8 December	12 12 0	8–9 December	
Data Processing	Manchester College of Commerce	14 October	2 10 0	15 weekly lectures	6.00 p.m.
Programming *IBM* 650	Manchester College of Commerce	21 September	2 0 0	12 weekly lectures	6.00–8.00 p.m.
Programming Pegasus	Manchester College of Commerce	22 September	2 0 0	12 weekly lectures	6.00–8.00 p.m.
Programming Hollerith 1202	Manchester College of Commerce	24 September	2 0 0	12 weekly lectures	6.00–8.00 p.m.
Programming National Elliott 405	Manchester College of Commerce	25 September	2 0 0	12 weekly lectures	6.00–8.00 p.m.
Computer Mathematics	Derby College of Technology	October 1959	15 0	October–December	Evening
Pegasus Autocode	Leicester College of Technology and Commerce	29 September	15 0	6 weekly lectures	6.30–8.00 p.m.
Deuce Alphacode	Leicester College of Technology and Commerce	10 November	15 0	6 weekly lectures	6.30–8.00 p.m.
Uses for Commerce	Nottingham Technical College	15 October	10 0	8 weekly lectures	
Digital Circuit Techniques	Borough Polytechnic, London	2 October		12 weekly lectures	7.00–9.00 p.m.
ADP Machines	Borough Polytechnic, London	28 September		12 weekly lectures	6.30–8.30 p.m.
Programming *IBM* 650	Brunel College, Acton, Middlesex	5 October		20 weekly lectures	7.00–8.15 p.m.
Programming Techniques	City of London College	14 October		5 weekly lectures	5.30–7.00 p.m.
Commercial Applications	Ealing Technical College, Middlesex	29 September		10 weekly lectures	9.15 a.m.–12.15 p.m.
Analogue Computer	Enfield Technical College, Middlesex	6 October		10 weekly lectures	7.00–9.00 p.m.
Analogue Computer	Hatfield Technical College, Middlesex	6 October		12 weekly lectures	7.00–9.00 p.m.
General Course	Hendon Technical College.	5 October		24 weekly lectures	3.00–5.00 p.m.
Aeronautical Applications	Northampton C.A.T., London	9 October		10 weekly lectures	6.45–9.00 p.m.
Analogue Computers Pt. I	Northampton C.A.T., London	28 September		6 weekly lectures	6.30 8.00 p.m.
Analogue Computers Pt. II	Northampton C.A.T., London	9 November		6 weekly lectures	6.30 8.00 p.m.
Commercial Applications (*ICT* Computers)	Northampton C.A.T., London	28 September		11 weekly lectures	6.30–8.00 p.m.
IBM Ramac	Northampton C.A.T., London	29 September		12 weekly lectures	6.30–8.00 p.m.
Elliott 802	Northampton C.A.T., London	30 September		12 weekly lectures	6.30–8.00 p.m.
Logical Design	Northampton C.A.T., London	29 September		10 weekly lectures	6.30–8.00 p.m.
Pegasus	Northampton C.A.T., London	30 September		24 weekly lectures	6.30–8.00 p.m.
Introductory Course	Northampton C.A.T., London	1 October		12 weekly lectures	6.30–8.00 p.m.
Computing for Civil Engineers	Northampton C.A.T., London	1 October		24 weekly lectures	3.30–4.30 and 5.30–7.00 p.m.

Course	*At*	*Commencing*	*Fee* £ *s.* *d.*	*Lectures or Sessions*	*Times*
Computer Techniques	Northampton C.A.T., London	30 September		8 weekly lectures	6.30–8.00 p.m.
General Course	North Western Polytechnic, London	13 October		10 weekly lectures	6.15–7.45 p.m.
Introductory Course	The Polytechnic, London	29 September		12 weekly lectures	
Programming	Slough College, Bucks	19 October		6 weekly lectures	7.00–9.00 p.m.
Analogue	Southall Technical College, Middlesex	7 October		10 weekly lectures	7.00–9.00 p.m.
General Course	Southall Technical College, Middlesex	29 September		12 weekly lectures	7.00–9.00 p.m.
Programming (Emidec 1100)	Twickenham Technical College, Middlesex	12 October		18 weekly lectures	at 7.00 p.m.
Computing Systems	Sir John Cass College, London	14 October		9 weekly lectures	6.30–8.00 p.m.
Pegasus Programming	Leeds University	13 October		20 sessions	
Programming Methods	Leeds University	1 December		8 lectures	
Logical Design	Leeds University	9 November		15 lectures	
Digital Computers in Industry	Bradford Institute of Technology	13 October		6 weekly lectures	Tuesdays 7.00–8.30 p.m.
Deuce Programming	Glasgow University	14 September		14–25 September	
Introductory Course	Glasgow University	October		10 weekly lectures	7.30–9.30 p.m.
Latest Developments	Birmingham College of Commerce	8 February		6 weekly lectures	6.30–9.00 p.m.
Ferrite Core Circuits	Coventry Technical College	January	1 0 0	8 weekly lectures	Fridays 7.00–9.00 p.m.
Electronic Office	Coventry Technical College	13 January	1 0 0	6 weekly lectures	7.00–8.30 p.m.
Mathematics, Computers and the Engineer	Rugby College of Technology	February		8 weekly lectures	Wednesdays
Analogue and Digital Computers	North Staffordshire Technical College	April	1 1 0	10 weekly lectures	
Analogue and Digital Computers	Rutherford College, Newcastle	January	1 1 0	12 weekly lectures	Thursdays 7.00–9.00 p.m.
Analogue Computers	Sunderland Technical College	13 January	1 1 0	8 weekly lectures	7.00 p.m.
IBM Fortran	Leicester College of Technology	12 January	15 0	6 weekly lectures	6.30–8.00 p.m.
Application to Office Work	Leicester College of Technology	1 March	15 0	6 weekly lectures	6.30–8.00 p.m.
Analogue Techniques	Nottingham Technical College	21 January	10 0	12 weekly lectures	

BOOK REVIEWS

Programming the IBM 650 *Magnetic Drum Computer and Data-Processing Machine*

By Richard V. Andree, 1958; 114 pages. (New York: *Henry Holt & Co., Inc.*, $2.95.)

This text is an introduction to programming the Basic 650, no consideration being given to the use of an on-line 407 Printer or to magnetic tapes. However, index registers and floating decimal codes are briefly considered.

It is a clear and well-illustrated introduction to the programming and operation of a 650 in a university computing laboratory, and highly suitable for use in connection with class or group tuition. The examples given at the end of each chapter are particularly useful in this context.

It is highly doubtful whether the author's introductory claim that the book is of value to users or potential users of other types of computers, has much basis in fact. The value of this book is for the potential 650 programmer. Certain of the author's statements, particularly those regarding operation and testing, are likely to be unacceptable to the commercial or industrial 650 user, however. For example, on p. 82 the author writes, "*Never* try to debug from a multiple load card," a conclusion which is as expensive as it is unnecessary. The author's style should not be allowed to bias the reader against this book. He suggests, for instance, that programs should be explained to someone who knows less about them, and adds, "Spouses, girl friends and beaus make ideal victims!"

Apart from machine language programming, he devotes brief chapters to SOAP (the 650 "Symbolic Optimal Assembly Programme"), Interpretive systems, using the Bell FLOPS system as his example, and compilers. He contends that "Fortransit" is an excellent language to use, though in fact it is so inefficient that its other advantages are more than outweighed.

Despite the criticisms of this text that have been cited, this book is undoubtedly of value, particularly for the chapters on machine language programming and for its examples and class exercises. If it is given to a single untrained programmer to read, care should be taken to correct some of the faulty impressions he might obtain from the sections on testing, operation and compilers. It is the best available text on programming the 650 and being considerably easier to assimilate than the published IBM manuals, forms an excellent introduction to them.

J. M. Playfer

Use of Electronic Data-Processing Equipment (Hearing before U.S. Congress Sub-Committee, June 1959)

1959; 142 pages. (Washington: *U.S. Government Printing Office.*)

Do not be put off by the long title of this document. It is in fact only 142 pages and is packed with interest. Indeed, it is the one pamphlet I have read recently which ought to be made compulsory reading for the Minister of Science and the Chancellor of the Exchequer, not to mention a lot of other people.

Its main purpose is to report a congressional hearing, at which senior civil servants of the Bureau of the Budget and of the General Accounting Office of the United States Administration are invited to testify. This part of the document will be of interest to most of us largely because of the unfamiliarity of the procedure, which involves public cross-examination of the witnesses. It is, consequently, in places extremely revealing on policy matters concerning, for instance, rental of equipment and use of manpower in the Government. Much of what is elicited from the experts by the Committee bears out some of the more fundamentalist views on the future of computers in administration. This is well summed up in the testimony on p. 29, where Mr. Mullins of the Bureau of the Budget states: ". . . manpower reduction is probably not going to be as important as the savings brought about through better management and through faster decisions," and again later, "I think it [the introduction of computers] practically amounts to a form of revolution in management. It is a very substantial change that most of us have just begun to appreciate fully."

However, the actual testimony only occupies a small section of the whole document. The remainder is taken up with the usual crop of appendices. These are of the utmost interest to all concerned in electronic data processing.

Appendix A presents a report on two uses of computing systems, one for the payment and reconciliation of Government checks, and one concerned with Savings Bond accounting. The former application, it is to be noted, has been in operation since June 1957, and it is claimed that over \$2¼ million are now being saved annually. Equipment for the latter application was only installed early in 1959, but it is anticipated that \$1 million annually will be saved in 1960, and that savings realised in 1959 have paid for the switch over to the new system. In each case there has been a substantial reduction in manpower requirements. In the first instance 485 out of a total of 755 personnel have been transferred to other work, whilst in the second case a net saving of 350 employees is claimed. These are impressive figures.

In Appendix B a survey of the progress and trend of development and use of *ADP* in the Federal Government, carried out by the General Accounting Office, is presented. This is a bit out of date, in so much as it only covers the period to December 1957. Nevertheless I do not think that many people in this country will find it so. I fear, rather, that they will dismiss it as far too advanced and radical in its thinking. After all, the "blue skies" approach was long ago discredited as an impractical dream of those scientist chaps—"at least twenty years off, old boy." If anyone still believes this after reading this report they are in for a rude shock in the next year or two. Here is concrete evidence that, in the United States Government at least, thinking on a massive scale was going on in 1958. There can be little doubt that very comprehensive systems will be in operation there in the near future.

Incidentally, whilst reading this Appendix, I began to get a severe inferiority complex, which was accentuated by a later appendix. This was engendered by the sheer weight of effort in the data processing field in the United States revealed here, compared with the puny efforts just beginning in this country.

It is, of course, only too easy to shrug it off with, "of course, they are much bigger than we are," and "clerical labour is much more expensive over there, and it would never be economic on the same scale here," and so on. What facile and frightening complacency on which to build the future of Britain! If anyone feels complacent about our own development, let them consider the figures given in this report for a moment. By the end of 1957 over a hundred systems costing 1 million dollars and up, and over one thousand costing several hundred thousand dollars were in operation within the Government agencies and in a diversity of companies covering the whole industrial and commercial field. The situation at twenty-four installations in Government agencies is given in detail in Appendix B. Although these are not all models of efficiency, on their own admission, there is evidence of much solid achievement along the lines of the installations reported on in Appendix A.

Nor is the pace of installation slackening. In Appendix C, for example, it is mentioned that a questionnaire concerning manpower sent out in late 1958 elicited that 237 large or medium scale installations were installed or on order within the United States Government alone, i.e. rather more than were projected in the whole of the United Kingdom in June 1959 (see, for instance, J. A. Goldsmith's review in *The Computer Journal*, Vol. 2, p. 97). There can be little doubt that this huge disparity in effort in an important labour and cost saving area cannot continue for long without the effect on our competitive position abroad being felt, even if all the improved control possibilities are not realised.

Appendix C is devoted to a study of manpower requirements within the Government up to 1963. The general conclusions of this report were endeared to me by one splendid sentence with regard to personnel practice. After diligent search for order, the reporting consultants reach the conclusion that "as a matter of fact, the pattern that emerges is one of relative patternlessness." Not even the fustiest civil servant could have done better, I feel sure! However, the detailed conclusions are not only written in a more illuminating vein but also point a moral which might be taken to heart in connection with our own affairs. This is that the pace of computer installations in the United States has outrun the capacity of the training facilities available for producing suitable personnel to run the installations. There is a manpower shortage there at present, which is thought to be likely to get worse over the next few years. There is every indication that this will happen here too. It behoves us, in the phraseology of the report, to "maximise the role of the Universities," both with regard to training and with regard to developing use of their facilities. In my view, everything possible must be done in the next few years to educate and encourage firms towards the installation of electronic data processing systems. Now is the time for all good men to come to the aid of the party!

A. S. Douglas

Proceedings of the Fifth Annual Computer Applications Symposium

1958; 153 pages. (Chicago: *Armour Research Foundation of Illinois Institute of Technology*, $3.00.)

The volume under review is a very well-produced record of the fourteen papers presented at the two-day conference. The papers are all by American authors and are equally divided between business and scientific applications.

All the papers comprising the first group are in the nature of reviews of various computer applications to, for example, banking, stores control and retrieval of information. Other papers of this group deal with optical recognition of printed characters and the very important question of input and output of data to and from a computer. The author of the paper on the latter subject suggests that, although peripheral equipment may be slow compared with the speed of arithmetic operations inside the computer proper, steps can be taken at the design stage to overcome such a deficiency.

The papers on scientific applications read on the second day are, in general, also in the nature of reviews. Some topics covered are: the numerical control of machine tools; the use of peripheral equipment to improve the overall speed of certain types of computations; non-linear programming and the collaborative effort made by several firms, all interested in highway engineering, to form a computing centre. There are two papers on automatic programming and also one, by R. W. Hamming, on "Frontiers in Computer Technology." In this very interesting paper Hamming puts forward ideas which he would like to see incorporated in any future computers; these suggestions, the author admits, are very much influenced by the fact that he is associated with the *Bell Telephones Laboratories*.

Included after each paper is a record of the discussion which followed and also reports of the two panel discussions. Editors of other proceedings of symposia would do well to emulate this volume.

G. N. Lance

Mathematical Programming and Electrical Networks

By J. B. Dennis, 1959; 186 pages. (Cambridge, Mass.: *The Technology Press;* New York: *John Wiley & Sons, Inc.;* London: *Chapman & Hall Ltd.*, 36s. 0d.)

We often have to base action on information, which although complete in that it allows of only one thing, does not state it directly. For example, we have to divide cash between employees given only a large sum of cash, information about rates of pay, hours of work, income tax code number and various rules. Faced with this situation we can either guess at the payments—not very satisfactory—be brilliant enough to see the answer in a flash, or do what I—and most of the rest of us—do, reach the solution by an orderly series of small steps which we know to lead us to the desired goal. I expect we would call the series of steps the way to solve the problem, or the method—or something like that. Some learned people would call the device an algorithm.

At school we learnt that all problems could be solved by one or other of the few standard methods we had been taught. In real life many problems—perhaps most of any real interest—have to be treated individually on their merits.

In each case we must first work for a method of solution. To do this most of us use the fact that methods for solving problems of apparently quite different type often have similar shapes. We see features of the problem to be solved that lead us to think that a method very much like one we use in fields very familiar to us might suit. We find clues to choosing a good analogy by which to argue. This kind of clue is sometimes called heuristic.

One class of problem which often must be solved in such a way is that sometimes called "mathematical programming." (A simple case of this is "linear programming" for which an algorithm does exist.) This meaning of "Mathematical Programming" which is the sense in which the words are used in the title of *Mathematical Programming and Electrical Networks* is, of course, a specialised one, and is quite distinct, for example, from such things as the digital computer programming of mathematical problems.

An example of a "Mathematical Programming" problem is:

"Where in London should one erect 'No entry—one way street' signs to minimise the average time taken for a bus to get from Marble Arch to Aldgate East?"

Such problems are what Dr. J. B. Dennis discusses in "Mathematical Programming and Electrical Networks."

In particular the book is about a set of heuristics based on familiarity with electrical network theory, and used to obtain methods for the solution of mathematical programming problems.

The particular sort of analogy and clue of heuristic we should use depends on our individual make-up. Those discussed by Dr. Dennis in his book would not be everyone's meat. Some, for instance, might prefer the geometric kind of analogy sometimes used by Dr. Albert W. Tucker to whom the book refers. Geometric analogies are used in the first part of "Mathematical Programming"—which deals with the nature of Programming problems and points out that Linear Programming—in which variables affect one another in the simplest possible way—is as mentioned above only one section of them.

The book follows this by a chapter showing that electrical networks containing voltage sources, current sources, ideal diodes, linear resistors and ideal D.C. transformers are very good analogies for many programming situations. The remainder of the book—the bulk of it—shows how to manipulate such networks to obtain algorithms for solving a wide range of programming problems.

The book is concisely written, but is not easy reading—indeed some might find even subjects they already thoroughly understand made difficult by it. Dr. Dennis makes extensive use of matrix notation and those who are not familiar with it would find it helpful to read a book on matrix algebra first. Also anyone who can obtain a copy of Dr. W. S. Percival's Ph.D. Thesis (to London University) or his papers published in the *Proceedings* of the Institution of Electrical Engineers on nodes, branches and tree structures in electrical circuits would find these a helpful preliminary to the book.

Anyone interested in programming problems, and who likes the idea of analogies based on electrical networks, will be well advised to read *Mathematical Programming and Electrical Networks*. He will find it very hard work, but given the right kind of mind, highly rewarding work. He will also find a good list of references.

E. A. Newman

Handbook of Automation Computation and Control, Volume 2

Edited by Eugene M. Grabbe, Simon Ramo, Dean E. Wooldridge; 1033 pages. (New York: *John Wiley & Sons*, 140s. 0d.)

This volume is the second to appear of a series of three. The first, which appeared some time ago, dealt with control fundamentals, and the third will deal with the systems and components used in industrial process control. The present volume deals with computers and data processing and is likely, therefore, to be of interest to many readers of this *Bulletin*. It is the product of collaboration between many contributors working under the general editors and under sectional editors; naturally the individual chapters vary much in treatment and in their degree of authority. The editors have wisely allowed a certain amount of overlapping in the preliminary definitions and introductory matter of the various chapters, but otherwise overlapping has been kept to a minimum. Each chapter has its own list of references at the end.

The longest chapter, and one of the most authoritative, is by Dr. John Carr, a former President of the *ACM*, and deals with programming for digital computers. This runs to 270 pages, including eight pages of references. It starts from first principles, but will probably be of most interest to those who are already experienced programmers. It contains an unusual amount of detail about machine order codes, the use of subroutines, automatic programming, and related topics; if, for example, you would like to see a program written in TX-O code you will find one here. Or, if you are curious to know what IT is and how it is related to SOAP, again you will find the information here.

The section on the use of digital computers and data processing machines contains about 160 pages. It deals only perfunctorily with scientific applications, but contains much of interest to business users. There are surveys of the types of equipment and facilities required for data processing, including a section on devices for character recognition; however, many readers' attention will be caught first by the descriptions given of examples of successful data processing installations. The following list gives the fields from which these examples are taken, with the type of machine used shown in brackets: life insurance (UNIVAC 1), casualty insurance (DATATRON), public utility billing (IBM 705), payroll (IBM 702, a forerunner of the 705), aircraft productivity scheduling (IBM 650).

In the section devoted to the design of digital computers there is an adequate discussion of the principles of logical design of complete computers and of their arithmetic and control units. There are also chapters on transistor circuits, and on the use of magnetic cores in conjunction with diodes and transistors for the construction of switching circuits. The design of coincident current ferrite matrix stores is well dealt with, and the main features of storage on magnetic drums and magnetic tape are covered. Input and output devices, including analogue-digital converters, are also treated. It is notoriously difficult to produce an up-to-date text on subjects connected with engineering practice, and one has the impression that this section of the book was planned and partly written some time ago. It will be of use primarily in providing reference material for students.

In the section on the design and application of analogue computers there is a good treatment of the now conventional electronic differential analyser based on feed-back amplifiers, including a treatment of non-linear circuit elements. Older mechanical integrating devices are not forgotten and there is a chapter on electrolytic tanks and other analogue devices for solving potential problems.

It throws an interesting side-light on the way in which analogue strongholds are being invaded by digital methods that the last chapter in the section on analogue computers should deal with digital techniques in analogue computation. This chapter should be read in conjunction with the first chapter of the following section (on unusual computer systems) which deals with the use of digital integrators and other units in operational control systems of the type in which analogue techniques are more commonly used. These two chapters will well repay study by anyone interested in industrial control. They include information about the digital differential analyser and its uses. Other chapters in the section on unusual computer systems deal with combined analogue-digital computing systems and with simple Turing-type computers.

It is not possible in reviewing a book of this type to mention every subject touched upon. In the present book there can be very few subjects of basic importance within the field that are wholly omitted. All the chapters will be of use to students and some, as I have indicated, will be of wider interest.

M. V. WILKES

Programming Business Computers

By Daniel D. McCracken, Harold Weiss and Tsai-Hwa Lee, 1959; 510 pages. (New York: *John Wiley & Sons, Inc.;* London: *Chapman & Hall Ltd.*, 82s. 0d.)

This is a very competent, skilful book on programming which will both serve the needs of a newcomer to coding and act as a refresher to the experienced. Unlike most earlier books on programming, it uses examples from problems arising in commercial data processing rather than in scientific or mathematical work, and, therefore, to the accountant or *O & M* man it will be all the more practical and easier to understand. This is not a book, however, that anyone wishing to gain "a quick appreciation of computers" (and there are many such people these days) should attempt to skim through, since it is a detailed exploration of the techniques and snags of programming using a mythical machine called DATAC. Not only does the book present the facts of a computer order code, which can be found in any programming manual, but also the explanation, motivation and interpretation of these facts as a general theory, which is not found in individual manuals.

The authors have experience of programming business applications and do well to introduce the subject with a discussion on files in commercial procedures, and then to stress the importance of flow charting before coming on to the actual coding. Other books tend to plunge straight into machine language coding and bring in flow charting almost as an afterthought. The authors are not afraid to take ample space to drive home the methods and instructions discussed, and in particular, multiplication and division processes are

thoroughly explained and will be of great advantage to the novice. This is not a book written by "experts" or "consultants" of at least six months' experience, which deals with all aspects of computers in less than 100 pages.

DATAC may not be an actual machine but it possesses some of the attributes of the latest computers, such as the interrupt facility on magnetic tape. This enables the authors to cover such subjects as re-run procedures, tape labels, tape sorting, indexing methods, etc., on which little seems to have been published. A great deal of needed attention is paid to the protection of data, the use of controls, and the large amount of housekeeping instructions required in commercial programs.

Though the subject-matter is not light, the book is not without humour, several amusing tales or quips being used to highlight particular points, such as, "if this seems like a rather lengthy process simply to prepare a name for printing, welcome to the club." The Appendix 3 called "A Data Processing Diary," which is reprinted from *Computing News*, is a hilarious account of how not to run a data processing installation.

The reviewer would have welcomed more on automatic programming, generators and compilers, time-sharing and the use of a two-level store. But for the non-mathematical systems analyst and programmer this is a book well worth its price since, in just over 500 pages, it moves gradually and smoothly from elementary functions to complicated data processing procedures.

R. M. PAINE

Digital Computer Primer

By E. M. McCORMICK, 1959; 214 pages. (London: *McGraw-Hill*, 58s. 0d.)

Quite a number of books have now appeared from either side of the Atlantic with the aim of explaining Digital Computers to the "well-informed layman." The author has had the opportunity of testing out his material in actual lecturing. This, the author tells us, produced changes both in content and manner of presentation. Were two of the results the introduction of problems and of paginated bibliographies at the ends of chapters? If so, the acid test of class-room presentation was well worth the effort for these alone.

His hypothetical computer has one-level storage and one accumulator and with this arrangement he covers efficiently the basic techniques of programming. Number systems, computer logic, address systems, hardware and checking receive lucid treatment and for the mathematically curious, an appendix offers Boolean algebra.

The author presumably decided that the role of "initial orders" was not a matter for a primer. Yet one can imagine the reader wondering how, in the first place, a computer could read in a program. British readers will also note that references are limited to American publications.

It is commendable that he devotes one sentence only to Babbage and Ada Augusta Lovelace, i.e. he refers the reader to the full history given in Bowden's book. It is highly commendable that he does not attempt in an introductory work to deal with complicated applications of computing. In short, the author has rightly limited himself to his stated objective and produced an excellent book which will profit the non-specialist.

The price of nearly £3 for a book of just over 200 pages may seem high for British readers but the work itself can be unreservedly recommended.

M. BRIDGER

Programming for an Automatic Digital Calculator

By Kathleen H. V. Booth, 1958; 238 pages. (London: *Butterworth's Scientific Publications*, 42s. New York: *Academic Press Inc.*, $7.50.)

This book contains a description of some of the subroutines and programs which have been written for the "All purpose electronic X-ray calculator" (APEXC) housed at Birkbeck College, London. Full particulars, including the detailed orders, are given for the following subroutines: input and output, division (which is not a built-in facility of the machine), square-root, sine and cosine, inverse cosine and integration (using Simpson's rule). The complete programs given include those for matrix multiplication, evaluation of the largest latent root of a matrix, the solution of up to twenty linear simultaneous equations and a program for mechanical translation of languages. There are also sections on the techniques of programming, floating point arithmetic and the checking or development of programs.

To whom is the book directed? One answer might be the newcomer to digital computers. However, the treatment is such that the beginner would be misled and in places confused. Moreover, by confining the study to the APEXC, the author gives a very restricted and one-sided picture of the subject, since this machine is not very typical of modern computers. For example, the APEXC requires the technique of optimum programming which is not the case with most present-day computers. Admittedly the order code is simple, but this means that the reader does not meet any of the logical orders "and," "or" and "not equivalent"; furthermore, since the APEXC has a single level store, the student learns nothing about computers with multilevel stores. The question of "overflow" is mentioned, but the machine has no facility for detecting this and the examples given do not bring out clearly enough the special precautions which should be taken on such a machine.

The question of checking is not treated adequately. The tape code used is such that some numbers can be changed to others by the insertion or omission of a single hole. The method recommended for getting tapes read correctly is to read them in twice and a subroutine checks that the second reading agrees with the first. Dr. Booth claims that such a check is adequate, but what happens if there is a consistent mis-reading by one of the brushes? The machine does not have a built-in parity check, and no mention is made of the fact that incorrect arithmetic might pass undetected.

To summarise, it is the reviewer's opinion that Dr. Booth has written a useful historical document. It is, however, not a book for the newcomer to digital computers. The printing is satisfactory but could be improved. (In places $\frac{1}{2}\sin \pi x$ is printed as $1/2 \sin \pi x$.)

G. N. LANCE.

Analytical Design of Linear Feedback Controls

By G. C. Newton, Jr., L. A. Gould and J. F. Kaiser, 1957; 419 pages. (New York: *John Wiley & Sons, Inc.;* London: *Chapman & Hall Ltd.*, 96s.)

The main chapters of the book provide a realistic approach to the fundamental problem of the control system designer—the problem of error minimisation. Use of the term "linear" in the book title is slightly misleading, the techniques presented being in fact applied to non-linear systems by using constraints in the design process, to restrict the magnitude of signals in the system to such a level that the non-linearity just operates over its linear region. It should be noted that the use of this technique may not always result in the most acceptable or economical system. For example, a non-linear system can be designed to give fastest possible response for a *range* of input signal amplitudes: with small input signals such a system is likely to respond faster and give a smaller steady-state error than would an optimum linear system with the same power drive but constrained to remain linear with the largest expected input signal.

First chapters deal with transient responses, the integral square error being minimised first without constraints, and then under constraints: for example, to avoid saturation of system components a given maximum allowable value of acceleration would be imposed.

Stochastic input signals and their mathematical representation in probability functions, and by correlation functions or by power spectra, are next considered. Minimisation of mean square error is shown to lead to the Wiener-Hopf integral equation, from which the transfer function of the optimum system may be obtained. The Wiener-Hopf equation is derived on the assumption that the system is completely free from any constraint either on the transfer function of system components or on the magnitude of signals which could cause power saturation. Further chapters extend the method to deal with both these constraints.

In order to reduce the complexity, physical size, and cost of a system, and yet meet specified performance requirements, the system bandwidth should be minimised. The procedure for this minimisation again results in an integral equation of the Wiener-Hopf form. In the final chapter the various design techniques are applied to a particularly exacting problem. Many shorter examples illustrating specific parts of the theory are also given in each chapter. The remaining portion of the book contains a series of useful appendices, including a review of conventional design techniques, and a table of integrals of the type commonly encountered in applying optimisation methods.

Altogether, the book provides a useful contribution to control systems analysis techniques, dealing comprehensively with the important and basic problem presented in the requirement of optimum design.

M. J. SOMERVILLE

Sampled-Data Control Systems

By Eliahu I. Jury, 1958; 453 pages. (New York: *John Wiley & Sons, Inc.;* London: *Chapman & Hall Ltd.*, 128s. 0d.)

A comprehensive and authoritative study is given of the theory of sampled-data systems. The basic theory of the sampling process is first developed, on the assumption of infinitely narrow sampling pulses. Z-transform methods enabling calculation of a system response at sampling instants only are then extended in the modified Z-transform, to allow investigation of intersample behaviour. The modified Z-transform is applied to consideration of stability in closed-loop systems, and also to analysis of systems containing a pure delay.

Root locus methods on the Z-plane are described, and correlated to the transient response. Stability criteria using frequency response techniques are next given, and applied to extensions of the conventional Routh and Nyquist or Bode methods.

A study of compensation techniques deals first with the use of a discrete compensator, methods of design to achieve factors such as dead-beat response, and minimum integral square error, being presented. Compensation using continuous networks is studied in some detail. The design then proves to be in general more difficult than with a discrete compensator, but has usually the practical advantage of being the easier and cheaper to implement. Several practical arrangements for achieving a compensator of given desired pulse transfer function characteristic are outlined.

Application of Z-transforms to give approximate evaluation of continuous system responses is next considered, by introducing a fictitious sample and hold into the circuit. Z-forms, and modified Z-forms are derived, these giving in general a better approximation and easier working than would be obtained using normal Z-transform analysis on the system with the fictitious sampler.

In the final chapter, finite pulse-width sampling is considered. A "p-transform" method is developed, this being effectively the Laplace transform of the sampled sequence, and is a function of both the sampling pulse width and sample period. P-transform methods are extended to the analysis of non-periodic sampling, delayed functions, and systems containing more than one sampler. Comprehensive tables of Z-transforms, modified Z-transforms, Z-forms, and p-transforms are included in the text.

Readers having an engineering rather than a purely mathematical background are likely to find the book difficult to follow: although the theory is backed up throughout by short worked examples, these are sometimes overwhelmed by the comprehensive theoretical treatment they are intended to illustrate. There is also a notable lack of any attempt to explain the physical significance of certain theoretical considerations. For example, in dealing with constant-M loci, M represents the peak gain from input sine wave to *sampled* output, and has a somewhat uncertain practical interpretation.

M. J. SOMERVILLE

NEWS FROM MANUFACTURERS

ORION for Sweden

An order worth about £280,000 has been placed with *Ferranti Ltd.* by the *AB Turitz & Co.* of Gothenburg, Sweden, for the first ORION data-processing system.

Turitz & Co. who operate the largest chain of multiple stores in Sweden as well as several large independent stores will make use of ORION for data-processing and stock control. It is expected that it will be installed about the end of 1961.

The system will be fitted with punched cards, magnetic tape and high-speed printers. One of its special features will be a system of 30 keyboards which will be installed in the Central Buying Department of the Company's head-quarters in Gothenburg. These will be operated by buyers so that information on stock levels throughout their network of 52 chain stores can be obtained immediately.

This new intelligence facility for quick stock control and purchasing is made possible because of the computer's time-sharing facilities. These enable the keyboards to be operated continuously, even though the computer itself is engaged on other data-processing work. If the computer is engaged, requests from the keyboards are stored by a system of priority processing and automatically answered when parts of the computer become available.

A production line for ORION computers has been laid down at the Company's West Gorton factory in Manchester. The computer for Sweden will be one of the first machines to come off the production line: two other machines will go into service at the Company's Computing Centres in London and Manchester.

Sperry Magnetic Drums

A range of magnetic storage drums is now in production at two main *Sperry* factories to meet the requirements of automatic telephone exchanges and the latest digital computers.

Magnetic storage drums, types A and B, developed in co-operation with *Automatic Telephone and Electric Co. Ltd.* for automatic telephone operation, but equally suitable for computer applications, are in production at the *Sperry* Brentford and Feltham factories, final assembly and testing taking place at the latter. These types, now coming off the assembly line in increasing numbers, are to be delivered to *GPO* exchanges throughout Britain, for subscriber trunk dialling (*STD*).

Type C units, very much larger, have been designed to meet the exacting requirements of computer manufacturers, in particular *Standard Telephones and Cables Ltd.* Production is already well under way at Brentford, to meet immediate orders and future demand. A particular feature of type C drums is the ability to couple units to provide a range of storage capacities to meet specific computer needs.

The type C drum has a recording surface 10 in. long and 12 in. in diameter with 250 tracks having a total capacity of 1,000,000 bits. The speed is 1,500 r.p.m. and there are 434 magnetic head positions.

Three ICT Computers for France

International Computers and Tabulators Ltd. have received orders from three commercial concerns in France for their medium-sized general purpose computer, the *ICT* Type 1202.

These are the first continental orders for this type of computer. The capital value of the machines and ancillary equipment to be delivered is of the order of £60,000 in each case.

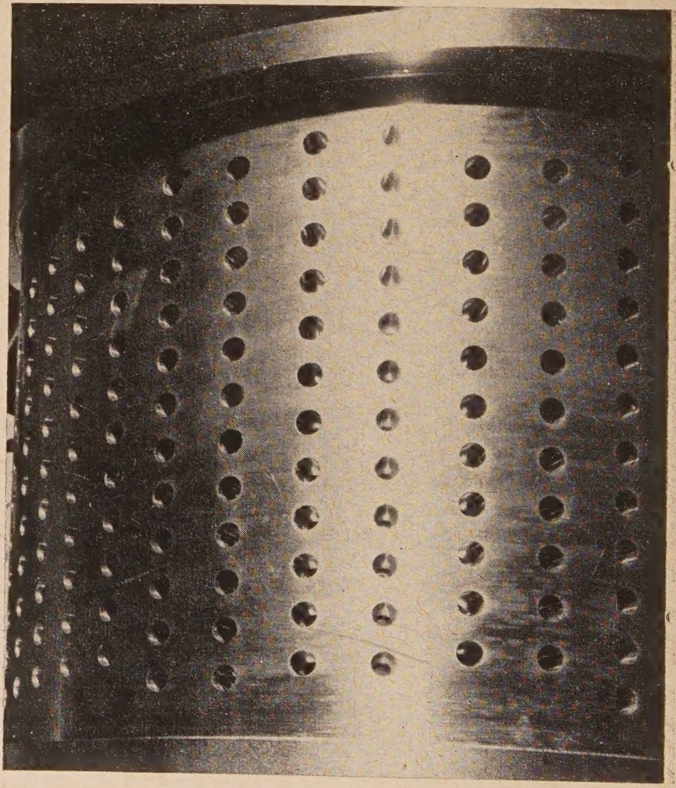
The orders have come from the following firms:

(i) *Etablissements Thibaud Gibbs Fragim et Cie*, of Paris, manufacturers of toilet preparations. They propose to use their computer for invoicing, sales accounting, stock control, vehicle loading and payroll, etc.

(ii) *Crédit Agricole*, Avignon, an important French organisation specialising in agricultural finance, who will be using their machine for a variety of banking tasks, including interest calculation.

(iii) *La Cité Vie*, Strasbourg, a large French insurance firm. Their computer will be used for insurance accounting, statistics, premium advice notes, etc.

All three companies are established users of punched-card equipment supplied by *SAMAS*, previously the French subsidiary of *Powers-Samas Accounting Machines Ltd.* In October of this year *SAMAS* became *ICT*—France, thus reflecting the merger of the parent company with the *British Tabulating Machine Company Ltd.*



Boring of Sperry Type C Magnetic Drum Mantle

The Elliott High Speed Punched Card Reader

The *Elliott* High Speed Punched Card Reader reads standard 65 and 80 column cards at speeds of up to 400 cards a minute, giving a reading rate of 533 characters per second. It is, therefore, one of the fastest punched card readers available for feeding information from punched cards into computers.

The mechanism reads 80 column punched cards of standard size ($7\frac{3}{8}$ in. $\times$ $3\frac{1}{4}$ in.) punched with rectangular holes, and 65 column cards punched with round holes, with or without verification. Each card is fed by energising the 2,000 ohm clutch magnet for a minimum period of 20 m/s. The bottom card in the magazine, which holds approximately 600 cards, is then picked off by a knife-edge and is fed with the long edge leading on to a platform, where it is momentarily halted. The direction of motion is changed after a temporary pause, the card being ejected sideways, with column 1 leading and at the same time the following card is fed on to the platform.

Sensing takes place during the ejection motion and is achieved photo-electrically by means of 12 photo-transistors over which the card passes immediately before passing through the ejection rollers. The first column passes the reading station approximately 30 m/s after a card feed order, and subsequent columns then pass at a rate of approximately 1·7 m/s per column.

Each individual card feed cycle, once initiated, cannot be controlled externally and the cycle will be completed automatically by the mechanism. When the clutch magnet is continuously energised the cards feed at the maximum rate of 400 cards per minute. The maximum rate is maintained with separate card feed orders provided that the order is given before the middle of the card. When the next card feed order is given immediately after the last column of the previous card, the feed rate is approximately 340 cards per minute. Further delay of the card feed orders produces slower feed rates. Due to the mechanical action of the clutch, it is not permissible to give a card feed order between the middle and end of a card. Conversion and assembly of characters must take place in the time lapse between reading adjacent columns.

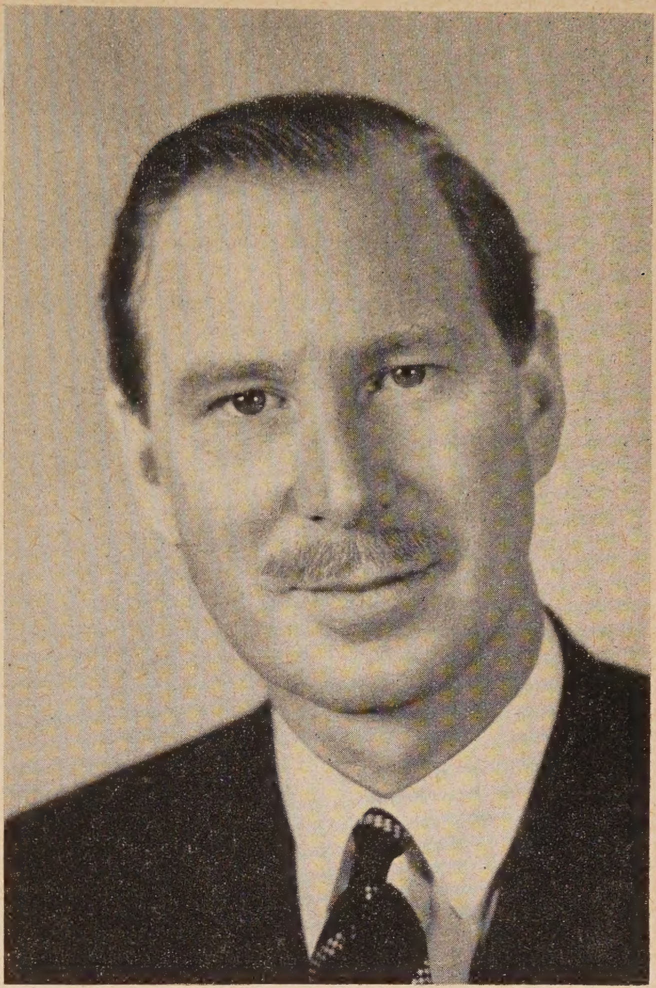
Character Reading

Solartron Electronic Business Machines Ltd. have received an order for an Electronic Reading Automaton from *Domestic Electric Rentals Ltd.* This application of the machine introduces a new method of rental and credit-sales accounting.

The *Solartron* ERA will read directly information recorded by *National Cash Register* machines at each branch of *Domestic Electrical Rentals* radio-TV rental organisation. This information, which will include the customer's account number and rental payment amount, will then be automatically punched at a far greater speed than is possible manually, on to 80-column *ICT* cards for subsequent use in a standard punched-card installation.

The *Solartron* ERA has been designed to recognise printed characters and to convert this information for use in punched-card or computer installations at a considerably lower cost than that of manual key punching. This reading and information conversion can take place at a speed of 200 to 300 characters per second with an accuracy far in excess of that achievable by human means, even after verification.

New Appointment



Mr. K. R. Barge
IBM World Trade Europe Corporation

Mr. K. R. Barge has recently been appointed Director of Data Processing Sales, European Area, at *IBM World Trade Europe* headquarters in Paris.

Mr. Barge joined *IBM United Kingdom Limited* in 1952 as a member of the Data Processing sales force. He was responsible for selling the first *IBM* 650 Computer in the United Kingdom, and followed this up with the first 650 Data Processing System incorporating magnetic tape.

In January 1956 he was promoted Manager of the Electronic Data Processing Machines Department, having responsibility for planning and programming customer's installations. In November of the same year he became Data Processing Sales Manager, and in January 1959, General Sales Manager.

Martins Bank Use Computer

Martins Bank Limited have ordered a PEGASUS II Computer, with paper tape input/output and four magnetic tape units, to perform current account book-keeping operations. A control computer installation will serve several branches, and it is estimated that 30,000 accounts can be dealt with in

five hours. The approximate price of the installation, due early in 1961, is £150,000. Since January 1960 the work of one branch has been run on the PEGASUS at *Ferranti's* London Computer Centre in order to test the system and the programs on live customer data.

The subject of banking on computers has normally been divided into two parts—(*a*) document handling, (*b*) book-keeping. *Martins Bank* have gone ahead with the book-keeping side before the various methods of sorting and reading cheques, etc., have been settled, but their aim is to make their system compatible with any future cheque-handling development.

A customer is given a personal number which is printed on his cheques. In this reorganisation the customers at the test branch have been very co-operative. At the branch, amounts and account numbers from cheques and credit notes are add-listed on Addo-X machines and a paper tape is produced at the same time. This paper tape is taken to the computer centre. Here the data of each branch is sorted daily into account number sequence by the computer and written on to magnetic tape.

The entries on this magnetic tape are then processed against the previous day's balances on magnetic tape to produce an up-dated balance file and a complete list of the balances of all customers. This list is returned to the appropriate branch. On another run any statements that are required are produced by processing current entries against the customers' history file on magnetic tape, and these are printed and sent to the branch in question.

A feature of this system is that all printing is performed on character printers working at about 12 characters a second from paper tapes which have been punched by the computer at speeds of 180 or more characters a second.

It is hoped that fuller details will be given in an article to appear in the next edition of the *Bulletin*.

1010 *under Test*

The first production model of the Central Computing Unit of the *AEI* 1010 Data Processing System manufactured by the *AEI Electronic Apparatus Division* at Trafford Park, Manchester, was completed on schedule and is now undergoing tests. Various items of peripheral equipment are being added and tested with the computer, which will be installed in a computer centre in the Manchester area.

The Division is not accepting orders for delivery before early 1961, by which time the first installation will have been running for a year.

An introductory course on the 1010 Data Processing System was held recently in the Trafford Park Works. The course was attended by representatives from a number of organisations who are prospective customers for the 1010.

Programming courses will be started in 1960 at the Computer Centre where the 1010 Data Processing System will be available for customers and prospective customers, to run and prove programmes written for their own applications.

The *AEI* 1010 Data Processing System (previously announced as the Metrovick 1010) has been specially designed so that a medium-sized installation costing about £150,000 can be expanded at will as data processing requirements grow. This is done by the addition of new ancillary equipment without any change to the Central Computing Unit being necessary.

A very powerful and flexible system can be built up which is capable of controlling up to 32 peripheral units, such as magnetic tape decks, paper tape and card readers, line printers, enquiry typewriters and paper tape and card punches. Facilities are available for parallel programming, interruption to execute priority work and multiple input and output. The computer is completely transistorised and can execute some 70,000 data processing instructions every second.

PEGASUS Orders

The *London and Manchester Assurance Co. Ltd.* have placed with *Ferranti Ltd.* an order for a £100,000 PEGASUS electronic data-processing system.

It is to be installed at the headquarters of the Company in London in October 1960, and will be used in the first instance for their ordinary branch accounting and valuation work.

This will involve the preparation of premium renewal notices, the associated control of payments, agency and Company accounting and the annual valuation of all the Company's life assurance policies.

A unified card file has already been set up using *ICT* equipment. Programs for the computer are being prepared and these will be largely proved on the machine before delivery.

The *Road Research Laboratory* of the *Department of Scientific and Industrial Research* have ordered a PEGASUS for all aspects of road research calculations, in particular, problems associated with road traffic and safety.

A third PEGASUS has been ordered by *The Steel Company of Wales*. Intended primarily for research studies, the computer is likely to be installed in the Operational Research Department at the Abbey Works, Port Talbot, within the next few months.

Total value of both these machines exceeds £150,000 and these orders bring to over 30 the total number of PEGASUS computers sold.

LEO II for Ilford

A LEO computer, costing around £250,000, has been ordered by *Ilford Ltd.* It will be used, initially, for the Company's payroll, and for producing invoices and statements for more than 30,000 customers in the retail trade, photo-finishing houses, hospitals and industry.

The system consists of a LEO IIC computer with transistorised immediate access magnetic core store, and two large auxiliary drum stores. Information can be read simultaneously from magnetic tapes, perforated paper tapes and punched cards, and results can (at the same time) be recorded on a 300-line-a-minute printer and on further magnetic tapes and cards.